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# ANNEX

International

# THE ELEMENTS

OF

# MECHANICAL ENGINEERING

PREPARED FOR STUDENTS OF THE

INTERNATIONAL CORRESPONDENCE SCHOOLS

SCRANTON, PA.

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**Volume V**

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## TABLES AND FORMULAS

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# TABLES AND FORMULAS.

This volume contains all the principal Tables and Formulas which are likely to be used by the student in practice. They have been collected and placed in this volume in order to make them convenient for ready reference, so that the student will not be obliged to hunt them out in the preceding volumes. The number after each formula is the same as the number following the same formula in the text.

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# TABLE

OF

# COMMON LOGARITHMS

## OF NUMBERS

### From 1 to 10,000.

| N. | Log. | N. | Log. | N. | Log. | N. | Log. | N. | Log. |
|---|---|---|---|---|---|---|---|---|---|
| **0** | — ∞ | **20** | 30 103 | **40** | 60 206 | **60** | 77 815 | **80** | 90 309 |
| 1 | 00 000 | 21 | 32 222 | 41 | 61 278 | 61 | 78 533 | 81 | 90 849 |
| 2 | 30 103 | 22 | 34 242 | 42 | 62 325 | 62 | 79 239 | 82 | 91 381 |
| 3 | 47 712 | 23 | 36 173 | 43 | 63 347 | 63 | 79 934 | 83 | 91 908 |
| 4 | 60 206 | 24 | 38 021 | 44 | 64 345 | 64 | 80 618 | 84 | 92 428 |
| 5 | 69 897 | 25 | 39 794 | 45 | 65 321 | 65 | 81 291 | 85 | 92 942 |
| 6 | 77 815 | 26 | 41 497 | 46 | 66 276 | 66 | 81 954 | 86 | 93 450 |
| 7 | 84 510 | 27 | 43 136 | 47 | 67 210 | 67 | 82 607 | 87 | 93 952 |
| 8 | 90 309 | 28 | 44 716 | 48 | 68 124 | 68 | 83 251 | 88 | 94 448 |
| 9 | 95 424 | 29 | 46 240 | 49 | 69 020 | 69 | 83 885 | 89 | 94 939 |
| **10** | 00 000 | **30** | 47 712 | **50** | 69 897 | **70** | 84 510 | **90** | 95 424 |
| 11 | 04 139 | 31 | 49 136 | 51 | 70 757 | 71 | 85 126 | 91 | 95 904 |
| 12 | 07 918 | 32 | 50 515 | 52 | 71 600 | 72 | 85 733 | 92 | 96 379 |
| 13 | 11 394 | 33 | 51 851 | 53 | 72 428 | 73 | 86 332 | 93 | 96 848 |
| 14 | 14 613 | 34 | 53 148 | 54 | 73 239 | 74 | 86 923 | 94 | 97 313 |
| 15 | 17 609 | 35 | 54 407 | 55 | 74 036 | 75 | 87 506 | 95 | 97 772 |
| 16 | 20 412 | 36 | 55 630 | 56 | 74 819 | 76 | 88 081 | 96 | 98 227 |
| 17 | 23 045 | 37 | 56 820 | 57 | 75 587 | 77 | 88 649 | 97 | 98 677 |
| 18 | 25 527 | 38 | 57 978 | 58 | 76 343 | 78 | 89 209 | 98 | 99 123 |
| 19 | 27 875 | 39 | 59 106 | 59 | 77 085 | 79 | 89 763 | 99 | 99 564 |
| **20** | 30 103 | **40** | 60 206 | **60** | 77 815 | **80** | 90 309 | **100** | 00 000 |

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **100** | 00 000 | 043 | 087 | 130 | 173 | 217 | 260 | 303 | 346 | 389 |
| 101 | 432 | 475 | 518 | 561 | 604 | 647 | 689 | 732 | 775 | 817 |
| 102 | 860 | 903 | 945 | 988 | *030 | *072 | *115 | *157 | *199 | *242 |
| 103 | 01 284 | 326 | 368 | 410 | 452 | 494 | 536 | 578 | 620 | 662 |
| 104 | 703 | 745 | 787 | 828 | 870 | 912 | 953 | 995 | *036 | *078 |
| 105 | 02 119 | 160 | 202 | 243 | 284 | 325 | 366 | 407 | 449 | 490 |
| 106 | 531 | 572 | 612 | 653 | 694 | 735 | 776 | 816 | 857 | 898 |
| 107 | 938 | 979 | *019 | *060 | *100 | *141 | *181 | *222 | *262 | *302 |
| 108 | 03 342 | 383 | 423 | 463 | 503 | 543 | 583 | 623 | 663 | 703 |
| 109 | 743 | 782 | 822 | 862 | 902 | 941 | 981 | *021 | *060 | *100 |
| **110** | 04 139 | 179 | 218 | 258 | 297 | 336 | 376 | 415 | 454 | 493 |
| 111 | 532 | 571 | 610 | 650 | 689 | 727 | 766 | 805 | 844 | 883 |
| 112 | 922 | 961 | 999 | *038 | *077 | *115 | *154 | *192 | *231 | *269 |
| 113 | 05 308 | 346 | 385 | 423 | 461 | 500 | 538 | 576 | 614 | 652 |
| 114 | 690 | 729 | 767 | 805 | 843 | 881 | 918 | 956 | 994 | *032 |
| 115 | 06 070 | 108 | 145 | 183 | 221 | 258 | 296 | 333 | 371 | 408 |
| 116 | 446 | 483 | 521 | 558 | 595 | 633 | 670 | 707 | 744 | 781 |
| 117 | 819 | 856 | 893 | 930 | 967 | *004 | *041 | *078 | *115 | *151 |
| 118 | 07 188 | 225 | 262 | 298 | 335 | 372 | 408 | 445 | 482 | 518 |
| 119 | 555 | 591 | 628 | 664 | 700 | 737 | 773 | 809 | 846 | 882 |
| **120** | 918 | 954 | 990 | *027 | *063 | *099 | *135 | *171 | *207 | *243 |
| 121 | 08 279 | 314 | 350 | 386 | 422 | 458 | 493 | 529 | 565 | 600 |
| 122 | 636 | 672 | 707 | 743 | 778 | 814 | 849 | 884 | 920 | 955 |
| 123 | 991 | *026 | *061 | *096 | *132 | *167 | *202 | *237 | *272 | *307 |
| 124 | 09 342 | 377 | 412 | 447 | 482 | 517 | 552 | 587 | 621 | 656 |
| 125 | 691 | 726 | 760 | 795 | 830 | 864 | 899 | 934 | 968 | *003 |
| 126 | 10 037 | 072 | 106 | 140 | 175 | 209 | 243 | 278 | 312 | 346 |
| 127 | 380 | 415 | 449 | 483 | 517 | 551 | 585 | 619 | 653 | 687 |
| 128 | 721 | 755 | 789 | 823 | 857 | 890 | 924 | 958 | 992 | *025 |
| 129 | 11 059 | 093 | 126 | 160 | 193 | 227 | 261 | 294 | 327 | 361 |
| **130** | 394 | 428 | 461 | 494 | 528 | 561 | 594 | 628 | 661 | 694 |
| 131 | 727 | 760 | 793 | 826 | 860 | 893 | 926 | 959 | 992 | *024 |
| 132 | 12 057 | 090 | 123 | 156 | 189 | 222 | 254 | 287 | 320 | 352 |
| 133 | 385 | 418 | 450 | 483 | 516 | 548 | 581 | 613 | 646 | 678 |
| 134 | 710 | 743 | 775 | 808 | 840 | 872 | 905 | 937 | 969 | *001 |
| 135 | 13 033 | 066 | 098 | 130 | 162 | 194 | 226 | 258 | 290 | 322 |
| 136 | 354 | 386 | 418 | 450 | 481 | 513 | 545 | 577 | 609 | 640 |
| 137 | 672 | 704 | 735 | 767 | 799 | 830 | 862 | 893 | 925 | 956 |
| 138 | 988 | *019 | *051 | *082 | *114 | *145 | *176 | *208 | *239 | *270 |
| 139 | 14 301 | 333 | 364 | 395 | 426 | 457 | 489 | 520 | 551 | 582 |
| **140** | 613 | 644 | 675 | 706 | 737 | 768 | 799 | 829 | 860 | 891 |
| 141 | 922 | 953 | 983 | *014 | *045 | *076 | *106 | *137 | *168 | *198 |
| 142 | 15 229 | 259 | 290 | 320 | 351 | 381 | 412 | 442 | 473 | 503 |
| 143 | 534 | 564 | 594 | 625 | 655 | 685 | 715 | 746 | 776 | 806 |
| 144 | 836 | 866 | 897 | 927 | 957 | 987 | *017 | *047 | *077 | *107 |
| 145 | 16 137 | 167 | 197 | 227 | 256 | 286 | 316 | 346 | 376 | 406 |
| 146 | 435 | 465 | 495 | 524 | 554 | 584 | 613 | 643 | 673 | 702 |
| 147 | 732 | 761 | 791 | 820 | 850 | 879 | 909 | 938 | 967 | 997 |
| 148 | 17 026 | 056 | 085 | 114 | 143 | 173 | 202 | 231 | 260 | 289 |
| 149 | 319 | 348 | 377 | 406 | 435 | 464 | 493 | 522 | 551 | 580 |
| **150** | 609 | 638 | 667 | 696 | 725 | 754 | 782 | 811 | 840 | 869 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 44 | 43 | 42 |
|---|---|---|---|
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| 2 | 8.8 | 8.6 | 8.4 |
| 3 | 13.2 | 12.9 | 12.6 |
| 4 | 17.6 | 17.2 | 16.8 |
| 5 | 22.0 | 21.5 | 21.0 |
| 6 | 26.4 | 25.8 | 25.2 |
| 7 | 30.8 | 30.1 | 29.4 |
| 8 | 35.2 | 34.4 | 33.6 |
| 9 | 39.6 | 38.7 | 37.8 |

| | 41 | 40 | 39 |
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| 3 | 12.3 | 12.0 | 11.7 |
| 4 | 16.4 | 16.0 | 15.6 |
| 5 | 20.5 | 20.0 | 19.5 |
| 6 | 24.6 | 24.0 | 23.4 |
| 7 | 28.7 | 28.0 | 27.3 |
| 8 | 32.8 | 32.0 | 31.2 |
| 9 | 36.9 | 36.0 | 35.1 |

| | 38 | 37 | 36 |
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| 3 | 11.4 | 11.1 | 10.8 |
| 4 | 15.2 | 14.8 | 14.4 |
| 5 | 19.0 | 18.5 | 18.0 |
| 6 | 22.8 | 22.2 | 21.6 |
| 7 | 26.6 | 25.9 | 25.2 |
| 8 | 30.4 | 29.6 | 28.8 |
| 9 | 34.2 | 33.3 | 32.4 |

| | 35 | 34 | 33 |
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| 2 | 7.0 | 6.8 | 6.6 |
| 3 | 10.5 | 10.2 | 9.9 |
| 4 | 14.0 | 13.6 | 13.2 |
| 5 | 17.5 | 17.0 | 16.5 |
| 6 | 21.0 | 20.4 | 19.8 |
| 7 | 24.5 | 23.8 | 23.1 |
| 8 | 28.0 | 27.2 | 26.4 |
| 9 | 31.5 | 30.6 | 29.7 |

| | 32 | 31 | 30 |
|---|---|---|---|
| 1 | 3.2 | 3.1 | 3.0 |
| 2 | 6.4 | 6.2 | 6.0 |
| 3 | 9.6 | 9.3 | 9.0 |
| 4 | 12.8 | 12.4 | 12.0 |
| 5 | 16.0 | 15.5 | 15.0 |
| 6 | 19.2 | 18.6 | 18.0 |
| 7 | 22.4 | 21.7 | 21.0 |
| 8 | 25.6 | 24.8 | 24.0 |
| 9 | 28.8 | 27.9 | 27.0 |

P. P.

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **150** | 17 609 | 638 | 667 | 696 | 725 | 754 | 782 | 811 | 840 | 869 |
| 151 | 898 | 926 | 955 | 984 | *013 | *041 | *070 | *099 | *127 | *156 |
| 152 | 18 184 | 213 | 241 | 270 | 298 | 327 | 355 | 384 | 412 | 441 |
| 153 | 469 | 498 | 526 | 554 | 583 | 611 | 639 | 667 | 696 | 724 |
| 154 | 752 | 780 | 808 | 837 | 865 | 893 | 921 | 949 | 977 | *005 |
| 155 | 19 033 | 061 | 089 | 117 | 145 | 173 | 201 | 229 | 257 | 285 |
| 156 | 312 | 340 | 368 | 396 | 424 | 451 | 479 | 507 | 535 | 562 |
| 157 | 590 | 618 | 645 | 673 | 700 | 728 | 756 | 783 | 811 | 838 |
| 158 | 866 | 893 | 921 | 948 | 976 | *003 | *030 | *058 | *085 | *112 |
| 159 | 20 140 | 167 | 194 | 222 | 249 | 276 | 303 | 330 | 358 | 385 |
| **160** | 412 | 439 | 466 | 493 | 520 | 548 | 575 | 602 | 629 | 656 |
| 161 | 683 | 710 | 737 | 763 | 790 | 817 | 844 | 871 | 898 | 925 |
| 162 | 952 | 978 | *005 | *032 | *059 | *085 | *112 | *139 | *165 | *192 |
| 163 | 21 219 | 245 | 272 | 299 | 325 | 352 | 378 | 405 | 431 | 458 |
| 164 | 484 | 511 | 537 | 564 | 590 | 617 | 643 | 669 | 696 | 722 |
| 165 | 748 | 775 | 801 | 827 | 854 | 880 | 906 | 932 | 958 | 985 |
| 166 | 22 011 | 037 | 063 | 089 | 115 | 141 | 167 | 194 | 220 | 246 |
| 167 | 272 | 298 | 324 | 350 | 376 | 401 | 427 | 453 | 479 | 505 |
| 168 | 531 | 557 | 583 | 608 | 634 | 660 | 686 | 712 | 737 | 763 |
| 169 | 789 | 814 | 840 | 866 | 891 | 917 | 943 | 968 | 994 | *019 |
| **170** | 23 045 | 070 | 096 | 121 | 147 | 172 | 198 | 223 | 249 | 274 |
| 171 | 300 | 325 | 350 | 376 | 401 | 426 | 452 | 477 | 502 | 528 |
| 172 | 553 | 578 | 603 | 629 | 654 | 679 | 704 | 729 | 754 | 779 |
| 173 | 805 | 830 | 855 | 880 | 905 | 930 | 955 | 980 | *005 | *030 |
| 174 | 24 055 | 080 | 105 | 130 | 155 | 180 | 204 | 229 | 254 | 279 |
| 175 | 304 | 329 | 353 | 378 | 403 | 428 | 452 | 477 | 502 | 527 |
| 176 | 551 | 576 | 601 | 625 | 650 | 674 | 699 | 724 | 748 | 773 |
| 177 | 797 | 822 | 846 | 871 | 895 | 920 | 944 | 969 | 993 | *018 |
| 178 | 25 042 | 066 | 091 | 115 | 139 | 164 | 188 | 212 | 237 | 261 |
| 179 | 285 | 310 | 334 | 358 | 382 | 406 | 431 | 455 | 479 | 503 |
| **180** | 527 | 551 | 575 | 600 | 624 | 648 | 672 | 696 | 720 | 744 |
| 181 | 768 | 792 | 816 | 840 | 864 | 888 | 912 | 935 | 959 | 983 |
| 182 | 26 007 | 031 | 055 | 079 | 102 | 126 | 150 | 174 | 198 | 221 |
| 183 | 245 | 269 | 293 | 316 | 340 | 364 | 387 | 411 | 435 | 458 |
| 184 | 482 | 505 | 529 | 553 | 576 | 600 | 623 | 647 | 670 | 694 |
| 185 | 717 | 741 | 764 | 788 | 811 | 834 | 858 | 881 | 905 | 928 |
| 186 | 951 | 975 | 998 | *021 | *045 | *068 | *091 | *114 | *138 | *161 |
| 187 | 27 184 | 207 | 231 | 254 | 277 | 300 | 323 | 346 | 370 | 393 |
| 188 | 416 | 439 | 462 | 485 | 508 | 531 | 554 | 577 | 600 | 623 |
| 189 | 646 | 669 | 692 | 715 | 738 | 761 | 784 | 807 | 830 | 852 |
| **190** | 875 | 898 | 921 | 944 | 967 | 989 | *012 | *035 | *058 | *081 |
| 191 | 28 103 | 126 | 149 | 171 | 194 | 217 | 240 | 262 | 285 | 307 |
| 192 | 330 | 353 | 375 | 398 | 421 | 443 | 466 | 488 | 511 | 533 |
| 193 | 556 | 578 | 601 | 623 | 646 | 668 | 691 | 713 | 735 | 758 |
| 194 | 780 | 803 | 825 | 847 | 870 | 892 | 914 | 937 | 959 | 981 |
| 195 | 29 003 | 026 | 048 | 070 | 092 | 115 | 137 | 159 | 181 | 203 |
| 196 | 226 | 248 | 270 | 292 | 314 | 336 | 358 | 380 | 403 | 425 |
| 197 | 447 | 469 | 491 | 513 | 535 | 557 | 579 | 601 | 623 | 645 |
| 198 | 667 | 688 | 710 | 732 | 754 | 776 | 798 | 820 | 842 | 863 |
| 199 | 885 | 907 | 929 | 951 | 973 | 994 | *016 | *038 | *060 | *081 |
| **200** | 30 103 | 125 | 146 | 168 | 190 | 211 | 233 | 255 | 276 | 298 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 29 | 28 |
|---|---|---|
| 1 | 2.9 | 2.8 |
| 2 | 5.8 | 5.6 |
| 3 | 8.7 | 8.4 |
| 4 | 11.6 | 11.2 |
| 5 | 14.5 | 14.0 |
| 6 | 17.4 | 16.8 |
| 7 | 20.3 | 19.6 |
| 8 | 23.2 | 22.4 |
| 9 | 26.1 | 25.2 |

| | 27 | 26 |
|---|---|---|
| 1 | 2.7 | 2.6 |
| 2 | 5.4 | 5.2 |
| 3 | 8.1 | 7.8 |
| 4 | 10.8 | 10.4 |
| 5 | 13.5 | 13.0 |
| 6 | 16.2 | 15.6 |
| 7 | 18.9 | 18.2 |
| 8 | 21.6 | 20.8 |
| 9 | 24.3 | 23.4 |

| | 25 |
|---|---|
| 1 | 2.5 |
| 2 | 5.0 |
| 3 | 7.5 |
| 4 | 10.0 |
| 5 | 12.5 |
| 6 | 15.0 |
| 7 | 17.5 |
| 8 | 20.0 |
| 9 | 22.5 |

| | 24 | 23 |
|---|---|---|
| 1 | 2.4 | 2.3 |
| 2 | 4.8 | 4.6 |
| 3 | 7.2 | 6.9 |
| 4 | 9.6 | 9.2 |
| 5 | 12.0 | 11.5 |
| 6 | 14.4 | 13.8 |
| 7 | 16.8 | 16.1 |
| 8 | 19.2 | 18.4 |
| 9 | 21.6 | 20.7 |

| | 22 | 21 |
|---|---|---|
| 1 | 2.2 | 2.1 |
| 2 | 4.4 | 4.2 |
| 3 | 6.6 | 6.3 |
| 4 | 8.8 | 8.4 |
| 5 | 11.0 | 10.5 |
| 6 | 13.2 | 12.6 |
| 7 | 15.4 | 14.7 |
| 8 | 17.6 | 16.8 |
| 9 | 19.8 | 18.9 |

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **200** | 30 103 | 125 | 146 | 168 | 190 | 211 | 233 | 255 | 276 | 298 |
| 201 | 320 | 341 | 363 | 384 | 406 | 428 | 449 | 471 | 492 | 514 |
| 202 | 535 | 557 | 578 | 600 | 621 | 643 | 664 | 685 | 707 | 728 |
| 203 | 750 | 771 | 792 | 814 | 835 | 856 | 878 | 899 | 920 | 942 |
| 204 | 963 | 984 | *006 | *027 | *048 | *069 | *091 | *112 | *133 | *154 |
| 205 | 31 175 | 197 | 218 | 239 | 260 | 281 | 302 | 323 | 345 | 366 |
| 206 | 387 | 408 | 429 | 450 | 471 | 492 | 513 | 534 | 555 | 576 |
| 207 | 597 | 618 | 639 | 660 | 681 | 702 | 723 | 744 | 765 | 785 |
| 208 | 806 | 827 | 848 | 869 | 890 | 911 | 931 | 952 | 973 | 994 |
| 209 | 32 015 | 035 | 056 | 077 | 098 | 118 | 139 | 160 | 181 | 201 |
| **210** | 222 | 243 | 263 | 284 | 305 | 325 | 346 | 366 | 387 | 408 |
| 211 | 428 | 449 | 469 | 490 | 510 | 531 | 552 | 572 | 593 | 613 |
| 212 | 634 | 654 | 675 | 695 | 715 | 736 | 756 | 777 | 797 | 818 |
| 213 | 838 | 858 | 879 | 899 | 919 | 940 | 960 | 980 | *001 | *021 |
| 214 | 33 041 | 062 | 082 | 102 | 122 | 143 | 163 | 183 | 203 | 224 |
| 215 | 244 | 264 | 284 | 304 | 325 | 345 | 365 | 385 | 405 | 425 |
| 216 | 445 | 465 | 486 | 506 | 526 | 546 | 566 | 586 | 606 | 626 |
| 217 | 646 | 666 | 686 | 706 | 726 | 746 | 766 | 786 | 806 | 826 |
| 218 | 846 | 866 | 885 | 905 | 925 | 945 | 965 | 985 | *005 | *025 |
| 219 | 34 044 | 064 | 084 | 104 | 124 | 143 | 163 | 183 | 203 | 223 |
| **220** | 242 | 262 | 282 | 301 | 321 | 341 | 361 | 380 | 400 | 420 |
| 221 | 439 | 459 | 479 | 498 | 518 | 537 | 557 | 577 | 596 | 616 |
| 222 | 635 | 655 | 674 | 694 | 713 | 733 | 753 | 772 | 792 | 811 |
| 223 | 830 | 850 | 869 | 889 | 908 | 928 | 947 | 967 | 986 | *005 |
| 224 | 35 025 | 044 | 064 | 083 | 102 | 122 | 141 | 160 | 180 | 199 |
| 225 | 218 | 238 | 257 | 276 | 295 | 315 | 334 | 353 | 372 | 392 |
| 226 | 411 | 430 | 449 | 468 | 488 | 507 | 526 | 545 | 564 | 583 |
| 227 | 603 | 622 | 641 | 660 | 679 | 698 | 717 | 736 | 755 | 774 |
| 228 | 793 | 813 | 832 | 851 | 870 | 889 | 908 | 927 | 946 | 965 |
| 229 | 984 | *003 | *021 | *040 | *059 | *078 | *097 | *116 | *135 | *154 |
| **230** | 36 173 | 192 | 211 | 229 | 248 | 267 | 286 | 305 | 324 | 342 |
| 231 | 361 | 380 | 399 | 418 | 436 | 455 | 474 | 493 | 511 | 530 |
| 232 | 549 | 568 | 586 | 605 | 624 | 642 | 661 | 680 | 698 | 717 |
| 233 | 736 | 754 | 773 | 791 | 810 | 829 | 847 | 866 | 884 | 903 |
| 234 | 922 | 940 | 959 | 977 | 996 | *014 | *033 | *051 | *070 | *088 |
| 235 | 37 107 | 125 | 144 | 162 | 181 | 199 | 218 | 236 | 254 | 273 |
| 236 | 291 | 310 | 328 | 346 | 365 | 383 | 401 | 420 | 438 | 457 |
| 237 | 475 | 493 | 511 | 530 | 548 | 566 | 585 | 603 | 621 | 639 |
| 238 | 658 | 676 | 694 | 712 | 731 | 749 | 767 | 785 | 803 | 822 |
| 239 | 840 | 858 | 876 | 894 | 912 | 931 | 949 | 967 | 985 | *003 |
| **240** | 38 021 | 039 | 057 | 075 | 093 | 112 | 130 | 148 | 166 | 184 |
| 241 | 202 | 220 | 238 | 256 | 274 | 292 | 310 | 328 | 346 | 364 |
| 242 | 382 | 399 | 417 | 435 | 453 | 471 | 489 | 507 | 525 | 543 |
| 243 | 561 | 578 | 596 | 614 | 632 | 650 | 668 | 686 | 703 | 721 |
| 244 | 739 | 757 | 775 | 792 | 810 | 828 | 846 | 863 | 881 | 899 |
| 245 | 917 | 934 | 952 | 970 | 987 | *005 | *023 | *041 | *058 | *076 |
| 246 | 39 094 | 111 | 129 | 146 | 164 | 182 | 199 | 217 | 235 | 252 |
| 247 | 270 | 287 | 305 | 322 | 340 | 358 | 375 | 393 | 410 | 428 |
| 248 | 445 | 463 | 480 | 498 | 515 | 533 | 550 | 568 | 585 | 602 |
| 249 | 620 | 637 | 655 | 672 | 690 | 707 | 724 | 742 | 759 | 777 |
| **250** | 794 | 811 | 829 | 846 | 863 | 881 | 898 | 915 | 933 | 950 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 22 | 21 |
|---|---|---|
| 1 | 2.2 | 2.1 |
| 2 | 4.4 | 4.2 |
| 3 | 6.6 | 6.3 |
| 4 | 8.8 | 8.4 |
| 5 | 11.0 | 10.5 |
| 6 | 13.2 | 12.6 |
| 7 | 15.4 | 14.7 |
| 8 | 17.6 | 16.8 |
| 9 | 19.8 | 18.9 |

| | 20 |
|---|---|
| 1 | 2.0 |
| 2 | 4.0 |
| 3 | 6.0 |
| 4 | 8.0 |
| 5 | 10.0 |
| 6 | 12.0 |
| 7 | 14.0 |
| 8 | 16.0 |
| 9 | 18.0 |

| | 19 |
|---|---|
| 1 | 1.9 |
| 2 | 3.8 |
| 3 | 5.7 |
| 4 | 7.6 |
| 5 | 9.5 |
| 6 | 11.4 |
| 7 | 13.3 |
| 8 | 15.2 |
| 9 | 17.1 |

| | 18 |
|---|---|
| 1 | 1.8 |
| 2 | 3.6 |
| 3 | 5.4 |
| 4 | 7.2 |
| 5 | 9.0 |
| 6 | 10.8 |
| 7 | 12.6 |
| 8 | 14.4 |
| 9 | 16.2 |

| | 17 |
|---|---|
| 1 | 1.7 |
| 2 | 3.4 |
| 3 | 5.1 |
| 4 | 6.8 |
| 5 | 8.5 |
| 6 | 10.2 |
| 7 | 11.9 |
| 8 | 13.6 |
| 9 | 15.3 |

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **250** | 39 794 | 811 | 829 | 846 | 863 | 881 | 898 | 915 | 933 | 950 |
| 251 | 967 | 985 | *002 | *019 | *037 | *054 | *071 | *088 | *106 | *123 |
| 252 | 40 140 | 157 | 175 | 192 | 209 | 226 | 243 | 261 | 278 | 295 |
| 253 | 312 | 329 | 346 | 364 | 381 | 398 | 415 | 432 | 449 | 466 |
| 254 | 483 | 500 | 518 | 535 | 552 | 569 | 586 | 603 | 620 | 637 |
| 255 | 654 | 671 | 688 | 705 | 722 | 739 | 756 | 773 | 790 | 807 |
| 256 | 824 | 841 | 858 | 875 | 892 | 909 | 926 | 943 | 960 | 976 |
| 257 | 993 | *010 | *027 | *044 | *061 | *078 | *095 | *111 | *128 | *145 |
| 258 | 41 162 | 179 | 196 | 212 | 229 | 246 | 263 | 280 | 296 | 313 |
| 259 | 330 | 347 | 363 | 380 | 397 | 414 | 430 | 447 | 464 | 481 |
| **260** | 497 | 514 | 531 | 547 | 564 | 581 | 597 | 614 | 631 | 647 |
| 261 | 664 | 681 | 697 | 714 | 731 | 747 | 764 | 780 | 797 | 814 |
| 262 | 830 | 847 | 863 | 880 | 896 | 913 | 929 | 946 | 963 | 979 |
| 263 | 996 | *012 | *029 | *045 | *062 | *078 | *095 | *111 | *127 | *144 |
| 264 | 42 160 | 177 | 193 | 210 | 226 | 243 | 259 | 275 | 292 | 308 |
| 265 | 325 | 341 | 357 | 374 | 390 | 406 | 423 | 439 | 455 | 472 |
| 266 | 488 | 504 | 521 | 537 | 553 | 570 | 586 | 602 | 619 | 635 |
| 267 | 651 | 667 | 684 | 700 | 716 | 732 | 749 | 765 | 781 | 797 |
| 268 | 813 | 830 | 846 | 862 | 878 | 894 | 911 | 927 | 943 | 959 |
| 269 | 975 | 991 | *008 | *024 | *040 | *056 | *072 | *088 | *104 | *120 |
| **270** | 43 136 | 152 | 169 | 185 | 201 | 217 | 233 | 249 | 265 | 281 |
| 271 | 297 | 313 | 329 | 345 | 361 | 377 | 393 | 409 | 425 | 441 |
| 272 | 457 | 473 | 489 | 505 | 521 | 537 | 553 | 569 | 584 | 600 |
| 273 | 616 | 632 | 648 | 664 | 680 | 696 | 712 | 727 | 743 | 759 |
| 274 | 775 | 791 | 807 | 823 | 838 | 854 | 870 | 886 | 902 | 917 |
| 275 | 933 | 949 | 965 | 981 | 996 | *012 | *028 | *044 | *059 | *075 |
| 276 | 44 091 | 107 | 122 | 138 | 154 | 170 | 185 | 201 | 217 | 232 |
| 277 | 248 | 264 | 279 | 295 | 311 | 326 | 342 | 358 | 373 | 389 |
| 278 | 404 | 420 | 436 | 451 | 467 | 483 | 498 | 514 | 529 | 545 |
| 279 | 560 | 576 | 592 | 607 | 623 | 638 | 654 | 669 | 685 | 700 |
| **280** | 716 | 731 | 747 | 762 | 778 | 793 | 809 | 824 | 840 | 855 |
| 281 | 871 | 886 | 902 | 917 | 932 | 948 | 963 | 979 | 994 | *010 |
| 282 | 45 025 | 040 | 056 | 071 | 086 | 102 | 117 | 133 | 148 | 163 |
| 283 | 179 | 194 | 209 | 225 | 240 | 255 | 271 | 286 | 301 | 317 |
| 284 | 332 | 347 | 362 | 378 | 393 | 408 | 423 | 439 | 454 | 469 |
| 285 | 484 | 500 | 515 | 530 | 545 | 561 | 576 | 591 | 606 | 621 |
| 286 | 637 | 652 | 667 | 682 | 697 | 712 | 728 | 743 | 758 | 773 |
| 287 | 788 | 803 | 818 | 834 | 849 | 864 | 879 | 894 | 909 | 924 |
| 288 | 939 | 954 | 969 | 984 | *000 | *015 | *030 | *045 | *060 | *075 |
| 289 | 46 090 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 |
| **290** | 240 | 255 | 270 | 285 | 300 | 315 | 330 | 345 | 359 | 374 |
| 291 | 389 | 404 | 419 | 434 | 449 | 464 | 479 | 494 | 509 | 523 |
| 292 | 538 | 553 | 568 | 583 | 598 | 613 | 627 | 642 | 657 | 672 |
| 293 | 687 | 702 | 716 | 731 | 746 | 761 | 776 | 790 | 805 | 820 |
| 294 | 835 | 850 | 864 | 879 | 894 | 909 | 923 | 938 | 953 | 967 |
| 295 | 982 | 997 | *012 | *026 | *041 | *056 | *070 | *085 | *100 | *114 |
| 296 | 47 129 | 144 | 159 | 173 | 188 | 202 | 217 | 232 | 246 | 261 |
| 297 | 276 | 290 | 305 | 319 | 334 | 349 | 363 | 378 | 392 | 407 |
| 298 | 422 | 436 | 451 | 465 | 480 | 494 | 509 | 524 | 538 | 553 |
| 299 | 567 | 582 | 596 | 611 | 625 | 640 | 654 | 669 | 683 | 698 |
| **300** | 712 | 727 | 741 | 756 | 770 | 784 | 799 | 813 | 828 | 842 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | | |
|---|---|---|
| | | **18** |
| | 1 | 1.8 |
| | 2 | 3.6 |
| | 3 | 5.4 |
| | 4 | 7.2 |
| | 5 | 9.0 |
| | 6 | 10.8 |
| | 7 | 12.6 |
| | 8 | 14.4 |
| | 9 | 16.2 |
| | | **17** |
| | 1 | 1.7 |
| | 2 | 3.4 |
| | 3 | 5.1 |
| | 4 | 6.8 |
| | 5 | 8.5 |
| | 6 | 10.2 |
| | 7 | 11.9 |
| | 8 | 13.6 |
| | 9 | 15.3 |
| | | **16** |
| | 1 | 1.6 |
| | 2 | 3.2 |
| | 3 | 4.8 |
| | 4 | 6.4 |
| | 5 | 8.0 |
| | 6 | 9.6 |
| | 7 | 11.2 |
| | 8 | 12.8 |
| | 9 | 14.4 |
| | | **15** |
| | 1 | 1.5 |
| | 2 | 3.0 |
| | 3 | 4.5 |
| | 4 | 6.0 |
| | 5 | 7.5 |
| | 6 | 9.0 |
| | 7 | 10.5 |
| | 8 | 12.0 |
| | 9 | 13.5 |
| | | **14** |
| | 1 | 1.4 |
| | 2 | 2.8 |
| | 3 | 4.2 |
| | 4 | 5.6 |
| | 5 | 7.0 |
| | 6 | 8.4 |
| | 7 | 9.8 |
| | 8 | 11.2 |
| | 9 | 12.6 |

P. P.

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | P. P. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **300** | 47 712 | 727 | 741 | 756 | 770 | 784 | 799 | 813 | 828 | 842 | |
| 301 | 857 | 871 | 885 | 900 | 914 | 929 | 943 | 958 | 972 | 986 | |
| 302 | 48 001 | 015 | 029 | 044 | 058 | 073 | 087 | 101 | 116 | 130 | |
| 303 | 144 | 159 | 173 | 187 | 202 | 216 | 230 | 244 | 259 | 273 | |
| 304 | 287 | 302 | 316 | 330 | 344 | 359 | 373 | 387 | 401 | 416 | |
| 305 | 430 | 444 | 458 | 473 | 487 | 501 | 515 | 530 | 544 | 558 | **15** |
| 306 | 572 | 586 | 601 | 615 | 629 | 643 | 657 | 671 | 686 | 700 | 1 \| 1.5 |
| 307 | 714 | 728 | 742 | 756 | 770 | 785 | 799 | 813 | 827 | 841 | 2 \| 3.0 |
| 308 | 855 | 869 | 883 | 897 | 911 | 926 | 940 | 954 | 968 | 982 | 3 \| 4.5 |
| 309 | 996 | *010 | *024 | *038 | *052 | *066 | *080 | *094 | *108 | *122 | 4 \| 6.0 |
| **310** | 49 136 | 150 | 164 | 178 | 192 | 206 | 220 | 234 | 248 | 262 | 5 \| 7.5 |
| 311 | 276 | 290 | 304 | 318 | 332 | 346 | 360 | 374 | 388 | 402 | 6 \| 9.0 |
| 312 | 415 | 429 | 443 | 457 | 471 | 485 | 499 | 513 | 527 | 541 | 7 \| 10.5 |
| 313 | 554 | 568 | 582 | 596 | 610 | 624 | 638 | 651 | 665 | 679 | 8 \| 12.0 |
| 314 | 693 | 707 | 721 | 734 | 748 | 762 | 776 | 790 | 803 | 817 | 9 \| 13.5 |
| 315 | 831 | 845 | 859 | 872 | 886 | 900 | 914 | 927 | 941 | 955 | |
| 316 | 969 | 982 | 996 | *010 | *024 | *037 | *051 | *065 | *079 | *092 | **14** |
| 317 | 50 106 | 120 | 133 | 147 | 161 | 174 | 188 | 202 | 215 | 229 | 1 \| 1.4 |
| 318 | 243 | 256 | 270 | 284 | 297 | 311 | 325 | 338 | 352 | 365 | 2 \| 2.8 |
| 319 | 379 | 393 | 406 | 420 | 433 | 447 | 461 | 474 | 488 | 501 | 3 \| 4.2 |
| **320** | 515 | 529 | 542 | 556 | 569 | 583 | 596 | 610 | 623 | 637 | 4 \| 5.6 |
| 321 | 651 | 664 | 678 | 691 | 705 | 718 | 732 | 745 | 759 | 772 | 5 \| 7.0 |
| 322 | 786 | 799 | 813 | 826 | 840 | 853 | 866 | 880 | 893 | 907 | 6 \| 8.4 |
| 323 | 920 | 934 | 947 | 961 | 974 | 987 | *001 | *014 | *028 | *041 | 7 \| 9.8 |
| 324 | 51 055 | 068 | 081 | 095 | 108 | 121 | 135 | 148 | 162 | 175 | 8 \| 11.2 |
| 325 | 188 | 202 | 215 | 228 | 242 | 255 | 268 | 282 | 295 | 308 | 9 \| 12.6 |
| 326 | 322 | 335 | 348 | 362 | 375 | 388 | 402 | 415 | 428 | 441 | |
| 327 | 455 | 468 | 481 | 495 | 508 | 521 | 534 | 548 | 561 | 574 | **13** |
| 328 | 587 | 601 | 614 | 627 | 640 | 654 | 667 | 680 | 693 | 706 | 1 \| 1.3 |
| 329 | 720 | 733 | 746 | 759 | 772 | 786 | 799 | 812 | 825 | 838 | 2 \| 2.6 |
| **330** | 851 | 865 | 878 | 891 | 904 | 917 | 930 | 943 | 957 | 970 | 3 \| 3.9 |
| 331 | 983 | 996 | *009 | *022 | *035 | *048 | *061 | *075 | *088 | *101 | 4 \| 5.2 |
| 332 | 52 114 | 127 | 140 | 153 | 166 | 179 | 192 | 205 | 218 | 231 | 5 \| 6.5 |
| 333 | 244 | 257 | 270 | 284 | 297 | 310 | 323 | 336 | 349 | 362 | 6 \| 7.8 |
| 334 | 375 | 388 | 401 | 414 | 427 | 440 | 453 | 466 | 479 | 492 | 7 \| 9.1 |
| 335 | 504 | 517 | 530 | 543 | 556 | 569 | 582 | 595 | 608 | 621 | 8 \| 10.4 |
| 336 | 634 | 647 | 660 | 673 | 686 | 699 | 711 | 724 | 737 | 750 | 9 \| 11.7 |
| 337 | 763 | 776 | 789 | 802 | 815 | 827 | 840 | 853 | 866 | 879 | |
| 338 | 892 | 905 | 917 | 930 | 943 | 956 | 969 | 982 | 994 | *007 | **12** |
| 339 | 53 020 | 033 | 046 | 058 | 071 | 084 | 097 | 110 | 122 | 135 | 1 \| 1.2 |
| **340** | 148 | 161 | 173 | 186 | 199 | 212 | 224 | 237 | 250 | 263 | 2 \| 2.4 |
| 341 | 275 | 288 | 301 | 314 | 326 | 339 | 352 | 364 | 377 | 390 | 3 \| 3.6 |
| 342 | 403 | 415 | 428 | 441 | 453 | 466 | 479 | 491 | 504 | 517 | 4 \| 4.8 |
| 343 | 529 | 542 | 555 | 567 | 580 | 593 | 605 | 618 | 631 | 643 | 5 \| 6.0 |
| 344 | 656 | 668 | 681 | 694 | 706 | 719 | 732 | 744 | 757 | 769 | 6 \| 7.2 |
| 345 | 782 | 794 | 807 | 820 | 832 | 845 | 857 | 870 | 882 | 895 | 7 \| 8.4 |
| 346 | 908 | 920 | 933 | 945 | 958 | 970 | 983 | 995 | *008 | *020 | 8 \| 9.6 |
| 347 | 54 033 | 045 | 058 | 070 | 083 | 095 | 108 | 120 | 133 | 145 | 9 \| 10.8 |
| 348 | 158 | 170 | 183 | 195 | 208 | 220 | 233 | 245 | 258 | 270 | |
| 349 | 283 | 295 | 307 | 320 | 332 | 345 | 357 | 370 | 382 | 394 | |
| **350** | 407 | 419 | 432 | 444 | 456 | 469 | 481 | 494 | 506 | 518 | |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | P. P. |

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **350** | 54 407 | 419 | 432 | 444 | 456 | 469 | 481 | 494 | 506 | 518 |
| 351 | 531 | 543 | 555 | 568 | 580 | 593 | 605 | 617 | 630 | 642 |
| 352 | 654 | 667 | 679 | 691 | 704 | 716 | 728 | 741 | 753 | 765 |
| 353 | 777 | 790 | 802 | 814 | 827 | 839 | 851 | 864 | 876 | 888 |
| 354 | 900 | 913 | 925 | 937 | 949 | 962 | 974 | 986 | 998 | *011 |
| 355 | 55 023 | 035 | 047 | 060 | 072 | 084 | 096 | 108 | 121 | 133 |
| 356 | 145 | 157 | 169 | 182 | 194 | 206 | 218 | 230 | 242 | 255 |
| 357 | 267 | 279 | 291 | 303 | 315 | 328 | 340 | 352 | 364 | 376 |
| 358 | 388 | 400 | 413 | 425 | 437 | 449 | 461 | 473 | 485 | 497 |
| 359 | 509 | 522 | 534 | 546 | 558 | 570 | 582 | 594 | 606 | 618 |
| **360** | 630 | 642 | 654 | 666 | 678 | 691 | 703 | 715 | 727 | 739 |
| 361 | 751 | 763 | 775 | 787 | 799 | 811 | 823 | 835 | 847 | 859 |
| 362 | 871 | 883 | 895 | 907 | 919 | 931 | 943 | 955 | 967 | 979 |
| 363 | 991 | *003 | *015 | *027 | *038 | *050 | *062 | *074 | *086 | *098 |
| 364 | 56 110 | 122 | 134 | 146 | 158 | 170 | 182 | 194 | 205 | 217 |
| 365 | 229 | 241 | 253 | 265 | 277 | 289 | 301 | 312 | 324 | 336 |
| 366 | 348 | 360 | 372 | 384 | 396 | 407 | 419 | 431 | 443 | 455 |
| 367 | 467 | 478 | 490 | 502 | 514 | 526 | 538 | 549 | 561 | 573 |
| 368 | 585 | 597 | 608 | 620 | 632 | 644 | 656 | 667 | 679 | 691 |
| 369 | 703 | 714 | 726 | 738 | 750 | 761 | 773 | 785 | 797 | 808 |
| **370** | 820 | 832 | 844 | 855 | 867 | 879 | 891 | 902 | 914 | 926 |
| 371 | 937 | 949 | 961 | 972 | 984 | 996 | *008 | *019 | *031 | *043 |
| 372 | 57 054 | 066 | 078 | 089 | 101 | 113 | 124 | 136 | 148 | 159 |
| 373 | 171 | 183 | 194 | 206 | 217 | 229 | 241 | 252 | 264 | 276 |
| 374 | 287 | 299 | 310 | 322 | 334 | 345 | 357 | 368 | 380 | 392 |
| 375 | 403 | 415 | 426 | 438 | 449 | 461 | 473 | 484 | 496 | 507 |
| 376 | 519 | 530 | 542 | 553 | 565 | 576 | 588 | 600 | 611 | 623 |
| 377 | 634 | 646 | 657 | 669 | 680 | 692 | 703 | 715 | 726 | 738 |
| 378 | 749 | 761 | 772 | 784 | 795 | 807 | 818 | 830 | 841 | 852 |
| 379 | 864 | 875 | 887 | 898 | 910 | 921 | 933 | 944 | 955 | 967 |
| **380** | 978 | 990 | *001 | *013 | *024 | *035 | *047 | *058 | *070 | *081 |
| 381 | 58 092 | 104 | 115 | 127 | 138 | 149 | 161 | 172 | 184 | 195 |
| 382 | 206 | 218 | 229 | 240 | 252 | 263 | 274 | 286 | 297 | 309 |
| 383 | 320 | 331 | 343 | 354 | 365 | 377 | 388 | 399 | 410 | 422 |
| 384 | 433 | 444 | 456 | 467 | 478 | 490 | 501 | 512 | 524 | 535 |
| 385 | 546 | 557 | 569 | 580 | 591 | 602 | 614 | 625 | 636 | 647 |
| 386 | 659 | 670 | 681 | 692 | 704 | 715 | 726 | 737 | 749 | 760 |
| 387 | 771 | 782 | 794 | 805 | 816 | 827 | 838 | 850 | 861 | 872 |
| 388 | 883 | 894 | 906 | 917 | 928 | 939 | 950 | 961 | 973 | 984 |
| 389 | 995 | *006 | *017 | *028 | *040 | *051 | *062 | *073 | *084 | *095 |
| **390** | 59 106 | 118 | 129 | 140 | 151 | 162 | 173 | 184 | 195 | 207 |
| 391 | 218 | 229 | 240 | 251 | 262 | 273 | 284 | 295 | 306 | 318 |
| 392 | 329 | 340 | 351 | 362 | 373 | 384 | 395 | 406 | 417 | 428 |
| 393 | 439 | 450 | 461 | 472 | 483 | 494 | 506 | 517 | 528 | 539 |
| 394 | 550 | 561 | 572 | 583 | 594 | 605 | 616 | 627 | 638 | 649 |
| 395 | 660 | 671 | 682 | 693 | 704 | 715 | 726 | 737 | 748 | 759 |
| 396 | 770 | 780 | 791 | 802 | 813 | 824 | 835 | 846 | 857 | 868 |
| 397 | 879 | 890 | 901 | 912 | 923 | 934 | 945 | 956 | 966 | 977 |
| 398 | 988 | 999 | *010 | *021 | *032 | *043 | *054 | *065 | *076 | *086 |
| 399 | 60 097 | 108 | 119 | 130 | 141 | 152 | 163 | 173 | 184 | 195 |
| **400** | 206 | 217 | 228 | 239 | 249 | 260 | 271 | 282 | 293 | 304 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | **13** | **12** | **11** | **10** |
|---|---|---|---|---|
| 1 | 1.3 | 1.2 | 1.1 | 1.0 |
| 2 | 2.6 | 2.4 | 2.2 | 2.0 |
| 3 | 3.9 | 3.6 | 3.3 | 3.0 |
| 4 | 5.2 | 4.8 | 4.4 | 4.0 |
| 5 | 6.5 | 6.0 | 5.5 | 5.0 |
| 6 | 7.8 | 7.2 | 6.6 | 6.0 |
| 7 | 9.1 | 8.4 | 7.7 | 7.0 |
| 8 | 10.4 | 9.6 | 8.8 | 8.0 |
| 9 | 11.7 | 10.8 | 9.9 | 9.0 |

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **400** | 60 206 | 217 | 228 | 239 | 249 | 260 | 271 | 282 | 293 | 304 |
| 401 | 314 | 325 | 336 | 347 | 358 | 369 | 379 | 390 | 401 | 412 |
| 402 | 423 | 433 | 444 | 455 | 466 | 477 | 487 | 498 | 509 | 520 |
| 403 | 531 | 541 | 552 | 563 | 574 | 584 | 595 | 606 | 617 | 627 |
| 404 | 638 | 649 | 660 | 670 | 681 | 692 | 703 | 713 | 724 | 735 |
| 405 | 746 | 756 | 767 | 778 | 788 | 799 | 810 | 821 | 831 | 842 |
| 406 | 853 | 863 | 874 | 885 | 895 | 906 | 917 | 927 | 938 | 949 |
| 407 | 959 | 970 | 981 | 991 | *002 | *013 | *023 | *034 | *045 | *055 |
| 408 | 61 066 | 077 | 087 | 098 | 109 | 119 | 130 | 140 | 151 | 162 |
| 409 | 172 | 183 | 194 | 204 | 215 | 225 | 236 | 247 | 257 | 268 |
| **410** | 278 | 289 | 300 | 310 | 321 | 331 | 342 | 352 | 363 | 374 |
| 411 | 384 | 395 | 405 | 416 | 426 | 437 | 448 | 458 | 469 | 479 |
| 412 | 490 | 500 | 511 | 521 | 532 | 542 | 553 | 563 | 574 | 584 |
| 413 | 595 | 606 | 616 | 627 | 637 | 648 | 658 | 669 | 679 | 690 |
| 414 | 700 | 711 | 721 | 731 | 742 | 752 | 763 | 773 | 784 | 794 |
| 415 | 805 | 815 | 826 | 836 | 847 | 857 | 868 | 878 | 888 | 899 |
| 416 | 909 | 920 | 930 | 941 | 951 | 962 | 972 | 982 | 993 | *003 |
| 417 | 62 014 | 024 | 034 | 045 | 055 | 066 | 076 | 086 | 097 | 107 |
| 418 | 118 | 128 | 138 | 149 | 159 | 170 | 180 | 190 | 201 | 211 |
| 419 | 221 | 232 | 242 | 252 | 263 | 273 | 284 | 294 | 304 | 315 |
| **420** | 325 | 335 | 346 | 356 | 366 | 377 | 387 | 397 | 408 | 418 |
| 421 | 428 | 439 | 449 | 459 | 469 | 480 | 490 | 500 | 511 | 521 |
| 422 | 531 | 542 | 552 | 562 | 572 | 583 | 593 | 603 | 613 | 624 |
| 423 | 634 | 644 | 655 | 665 | 675 | 685 | 696 | 706 | 716 | 726 |
| 424 | 737 | 747 | 757 | 767 | 778 | 788 | 798 | 808 | 818 | 829 |
| 425 | 839 | 849 | 859 | 870 | 880 | 890 | 900 | 910 | 921 | 931 |
| 426 | 941 | 951 | 961 | 972 | 982 | 992 | *002 | *012 | *022 | *033 |
| 427 | 63 043 | 053 | 063 | 073 | 083 | 094 | 104 | 114 | 124 | 134 |
| 428 | 144 | 155 | 165 | 175 | 185 | 195 | 205 | 215 | 225 | 236 |
| 429 | 246 | 256 | 266 | 276 | 286 | 296 | 306 | 317 | 327 | 337 |
| **430** | 347 | 357 | 367 | 377 | 387 | 397 | 407 | 417 | 428 | 438 |
| 431 | 448 | 458 | 468 | 478 | 488 | 498 | 508 | 518 | 528 | 538 |
| 432 | 548 | 558 | 568 | 579 | 589 | 599 | 609 | 619 | 629 | 639 |
| 433 | 649 | 659 | 669 | 679 | 689 | 699 | 709 | 719 | 729 | 739 |
| 434 | 749 | 759 | 769 | 779 | 789 | 799 | 809 | 819 | 829 | 839 |
| 435 | 849 | 859 | 869 | 879 | 889 | 899 | 909 | 919 | 929 | 939 |
| 436 | 949 | 959 | 969 | 979 | 988 | 998 | *008 | *018 | *028 | *038 |
| 437 | 64 048 | 058 | 068 | 078 | 088 | 098 | 108 | 118 | 128 | 137 |
| 438 | 147 | 157 | 167 | 177 | 187 | 197 | 207 | 217 | 227 | 237 |
| 439 | 246 | 256 | 266 | 276 | 286 | 296 | 306 | 316 | 326 | 335 |
| **440** | 345 | 355 | 365 | 375 | 385 | 395 | 404 | 414 | 424 | 434 |
| 441 | 444 | 454 | 464 | 473 | 483 | 493 | 503 | 513 | 523 | 532 |
| 442 | 542 | 552 | 562 | 572 | 582 | 591 | 601 | 611 | 621 | 631 |
| 443 | 640 | 650 | 660 | 670 | 680 | 689 | 699 | 709 | 719 | 729 |
| 444 | 738 | 748 | 758 | 768 | 777 | 787 | 797 | 807 | 816 | 826 |
| 445 | 836 | 846 | 856 | 865 | 875 | 885 | 895 | 904 | 914 | 924 |
| 446 | 933 | 943 | 953 | 963 | 972 | 982 | 992 | *002 | *011 | *021 |
| 447 | 65 031 | 040 | 050 | 060 | 070 | 079 | 089 | 099 | 108 | 118 |
| 448 | 128 | 137 | 147 | 157 | 167 | 176 | 186 | 196 | 205 | 215 |
| 449 | 225 | 234 | 244 | 254 | 263 | 273 | 283 | 292 | 302 | 312 |
| **450** | 321 | 331 | 341 | 350 | 360 | 369 | 379 | 389 | 398 | 408 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | **11** |
|---|---|
| 1 | 1.1 |
| 2 | 2.2 |
| 3 | 3.3 |
| 4 | 4.4 |
| 5 | 5.5 |
| 6 | 6.6 |
| 7 | 7.7 |
| 8 | 8.8 |
| 9 | 9.9 |

| | **10** |
|---|---|
| 1 | 1.0 |
| 2 | 2.0 |
| 3 | 3.0 |
| 4 | 4.0 |
| 5 | 5.0 |
| 6 | 6.0 |
| 7 | 7.0 |
| 8 | 8.0 |
| 9 | 9.0 |

| | **9** |
|---|---|
| 1 | 0.9 |
| 2 | 1.8 |
| 3 | 2.7 |
| 4 | 3.6 |
| 5 | 4.5 |
| 6 | 5.4 |
| 7 | 6.3 |
| 8 | 7.2 |
| 9 | 8.1 |

P. P.

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **450** | 65 321 | 331 | 341 | 350 | 360 | 369 | 379 | 389 | 398 | 408 |
| 451 | 418 | 427 | 437 | 447 | 456 | 466 | 475 | 485 | 495 | 504 |
| 452 | 514 | 523 | 533 | 543 | 552 | 562 | 571 | 581 | 591 | 600 |
| 453 | 610 | 619 | 629 | 639 | 648 | 658 | 667 | 677 | 686 | 696 |
| 454 | 706 | 715 | 725 | 734 | 744 | 753 | 763 | 772 | 782 | 792 |
| 455 | 801 | 811 | 820 | 830 | 839 | 849 | 858 | 868 | 877 | 887 |
| 456 | 896 | 906 | 916 | 925 | 935 | 944 | 954 | 963 | 973 | 982 |
| 457 | 992 | *001 | *011 | *020 | *030 | *039 | *049 | *058 | *068 | *077 |
| 458 | 66 087 | 096 | 106 | 115 | 124 | 134 | 143 | 153 | 162 | 172 |
| 459 | 181 | 191 | 200 | 210 | 219 | 229 | 238 | 247 | 257 | 266 |
| **460** | 276 | 285 | 295 | 304 | 314 | 323 | 332 | 342 | 351 | 361 |
| 461 | 370 | 380 | 389 | 398 | 408 | 417 | 427 | 436 | 445 | 455 |
| 462 | 464 | 474 | 483 | 492 | 502 | 511 | 521 | 530 | 539 | 549 |
| 463 | 558 | 567 | 577 | 586 | 596 | 605 | 614 | 624 | 633 | 642 |
| 464 | 652 | 661 | 671 | 680 | 689 | 699 | 708 | 717 | 727 | 736 |
| 465 | 745 | 755 | 764 | 773 | 783 | 792 | 801 | 811 | 820 | 829 |
| 466 | 839 | 848 | 857 | 867 | 876 | 885 | 894 | 904 | 913 | 922 |
| 467 | 932 | 941 | 950 | 960 | 969 | 978 | 987 | 997 | *006 | *015 |
| 468 | 67 025 | 034 | 043 | 052 | 062 | 071 | 080 | 089 | 099 | 108 |
| 469 | 117 | 127 | 136 | 145 | 154 | 164 | 173 | 182 | 191 | 201 |
| **470** | 210 | 219 | 228 | 237 | 247 | 256 | 265 | 274 | 284 | 293 |
| 471 | 302 | 311 | 321 | 330 | 339 | 348 | 357 | 367 | 376 | 385 |
| 472 | 394 | 403 | 413 | 422 | 431 | 440 | 449 | 459 | 468 | 477 |
| 473 | 486 | 495 | 504 | 514 | 523 | 532 | 541 | 550 | 560 | 569 |
| 474 | 578 | 587 | 596 | 605 | 614 | 624 | 633 | 642 | 651 | 660 |
| 475 | 669 | 679 | 688 | 697 | 706 | 715 | 724 | 733 | 742 | 752 |
| 476 | 761 | 770 | 779 | 788 | 797 | 806 | 815 | 825 | 834 | 843 |
| 477 | 852 | 861 | 870 | 879 | 888 | 897 | 906 | 916 | 925 | 934 |
| 478 | 943 | 952 | 961 | 970 | 979 | 988 | 997 | *006 | *015 | *024 |
| 479 | 68 034 | 043 | 052 | 061 | 070 | 079 | 088 | 097 | 106 | 115 |
| **480** | 124 | 133 | 142 | 151 | 160 | 169 | 178 | 187 | 196 | 205 |
| 481 | 215 | 224 | 233 | 242 | 251 | 260 | 269 | 278 | 287 | 296 |
| 482 | 305 | 314 | 323 | 332 | 341 | 350 | 359 | 368 | 377 | 386 |
| 483 | 395 | 404 | 413 | 422 | 431 | 440 | 449 | 458 | 467 | 476 |
| 484 | 485 | 494 | 502 | 511 | 520 | 529 | 538 | 547 | 556 | 565 |
| 485 | 574 | 583 | 592 | 601 | 610 | 619 | 628 | 637 | 646 | 655 |
| 486 | 664 | 673 | 681 | 690 | 699 | 708 | 717 | 726 | 735 | 744 |
| 487 | 753 | 762 | 771 | 780 | 789 | 797 | 806 | 815 | 824 | 833 |
| 488 | 842 | 851 | 860 | 869 | 878 | 886 | 895 | 904 | 913 | 922 |
| 489 | 931 | 940 | 949 | 958 | 966 | 975 | 984 | 993 | *002 | *011 |
| **490** | 69 020 | 028 | 037 | 046 | 055 | 064 | 073 | 082 | 090 | 099 |
| 491 | 108 | 117 | 126 | 135 | 144 | 152 | 161 | 170 | 179 | 188 |
| 492 | 197 | 205 | 214 | 223 | 232 | 241 | 249 | 258 | 267 | 276 |
| 493 | 285 | 294 | 302 | 311 | 320 | 329 | 338 | 346 | 355 | 364 |
| 494 | 373 | 381 | 390 | 399 | 408 | 417 | 425 | 434 | 443 | 452 |
| 495 | 461 | 469 | 478 | 487 | 496 | 504 | 513 | 522 | 531 | 539 |
| 496 | 548 | 557 | 566 | 574 | 583 | 592 | 601 | 609 | 618 | 627 |
| 497 | 636 | 644 | 653 | 662 | 671 | 679 | 688 | 697 | 705 | 714 |
| 498 | 723 | 732 | 740 | 749 | 758 | 767 | 775 | 784 | 793 | 801 |
| 499 | 810 | 819 | 827 | 836 | 845 | 854 | 862 | 871 | 880 | 888 |
| **500** | 897 | 906 | 914 | 923 | 932 | 940 | 949 | 958 | 966 | 975 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 10 |
|---|---|
| 1 | 1.0 |
| 2 | 2.0 |
| 3 | 3.0 |
| 4 | 4.0 |
| 5 | 5.0 |
| 6 | 6.0 |
| 7 | 7.0 |
| 8 | 8.0 |
| 9 | 9.0 |

| | 9 |
|---|---|
| 1 | 0.9 |
| 2 | 1.8 |
| 3 | 2.7 |
| 4 | 3.6 |
| 5 | 4.5 |
| 6 | 5.4 |
| 7 | 6.3 |
| 8 | 7.2 |
| 9 | 8.1 |

| | 8 |
|---|---|
| 1 | 0.8 |
| 2 | 1.6 |
| 3 | 2.4 |
| 4 | 3.2 |
| 5 | 4.0 |
| 6 | 4.8 |
| 7 | 5.6 |
| 8 | 6.4 |
| 9 | 7.2 |

P. P.

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **500** | 69 897 | 906 | 914 | 923 | 932 | 940 | 949 | 958 | 966 | 975 |
| 501 | 984 | 992 | *001 | *010 | *018 | *027 | *036 | *044 | *053 | *062 |
| 502 | 70 070 | 079 | 088 | 096 | 105 | 114 | 122 | 131 | 140 | 148 |
| 503 | 157 | 165 | 174 | 183 | 191 | 200 | 209 | 217 | 226 | 234 |
| 504 | 243 | 252 | 260 | 269 | 278 | 286 | 295 | 303 | 312 | 321 |
| 505 | 329 | 338 | 346 | 355 | 364 | 372 | 381 | 389 | 398 | 406 |
| 506 | 415 | 424 | 432 | 441 | 449 | 458 | 467 | 475 | 484 | 492 |
| 507 | 501 | 509 | 518 | 526 | 535 | 544 | 552 | 561 | 569 | 578 |
| 508 | 586 | 595 | 603 | 612 | 621 | 629 | 638 | 646 | 655 | 663 |
| 509 | 672 | 680 | 689 | 697 | 706 | 714 | 723 | 731 | 740 | 749 |
| **510** | 757 | 766 | 774 | 783 | 791 | 800 | 808 | 817 | 825 | 834 |
| 511 | 842 | 851 | 859 | 868 | 876 | 885 | 893 | 902 | 910 | 919 |
| 512 | 927 | 935 | 944 | 952 | 961 | 969 | 978 | 986 | 995 | *003 |
| 513 | 71 012 | 020 | 029 | 037 | 046 | 054 | 063 | 071 | 079 | 088 |
| 514 | 096 | 105 | 113 | 122 | 130 | 139 | 147 | 155 | 164 | 172 |
| 515 | 181 | 189 | 198 | 206 | 214 | 223 | 231 | 240 | 248 | 257 |
| 516 | 265 | 273 | 282 | 290 | 299 | 307 | 315 | 324 | 332 | 341 |
| 517 | 349 | 357 | 366 | 374 | 383 | 391 | 399 | 408 | 416 | 425 |
| 518 | 433 | 441 | 450 | 458 | 466 | 475 | 483 | 492 | 500 | 508 |
| 519 | 517 | 525 | 533 | 542 | 550 | 559 | 567 | 575 | 584 | 592 |
| **520** | 600 | 609 | 617 | 625 | 634 | 642 | 650 | 659 | 667 | 675 |
| 521 | 684 | 692 | 700 | 709 | 717 | 725 | 734 | 742 | 750 | 759 |
| 522 | 767 | 775 | 784 | 792 | 800 | 809 | 817 | 825 | 834 | 842 |
| 523 | 850 | 858 | 867 | 875 | 883 | 892 | 900 | 908 | 917 | 925 |
| 524 | 933 | 941 | 950 | 958 | 966 | 975 | 983 | 991 | 999 | *008 |
| 525 | 72 016 | 024 | 032 | 041 | 049 | 057 | 066 | 074 | 082 | 090 |
| 526 | 099 | 107 | 115 | 123 | 132 | 140 | 148 | 156 | 165 | 173 |
| 527 | 181 | 189 | 198 | 206 | 214 | 222 | 230 | 239 | 247 | 255 |
| 528 | 263 | 272 | 280 | 288 | 296 | 304 | 313 | 321 | 329 | 337 |
| 529 | 346 | 354 | 362 | 370 | 378 | 387 | 395 | 403 | 411 | 419 |
| **530** | 428 | 436 | 444 | 452 | 460 | 469 | 477 | 485 | 493 | 501 |
| 531 | 509 | 518 | 526 | 534 | 542 | 550 | 558 | 567 | 575 | 583 |
| 532 | 591 | 599 | 607 | 616 | 624 | 632 | 640 | 648 | 656 | 665 |
| 533 | 673 | 681 | 689 | 697 | 705 | 713 | 722 | 730 | 738 | 746 |
| 534 | 754 | 762 | 770 | 779 | 787 | 795 | 803 | 811 | 819 | 827 |
| 535 | 835 | 843 | 852 | 860 | 868 | 876 | 884 | 892 | 900 | 908 |
| 536 | 916 | 925 | 933 | 941 | 949 | 957 | 965 | 973 | 981 | 989 |
| 537 | 997 | *006 | *014 | *022 | *030 | *038 | *046 | *054 | *062 | *070 |
| 538 | 73 078 | 086 | 094 | 102 | 111 | 119 | 127 | 135 | 143 | 151 |
| 539 | 159 | 167 | 175 | 183 | 191 | 199 | 207 | 215 | 223 | 231 |
| **540** | 239 | 247 | 255 | 263 | 272 | 280 | 288 | 296 | 304 | 312 |
| 541 | 320 | 328 | 336 | 344 | 352 | 360 | 368 | 376 | 384 | 392 |
| 542 | 400 | 408 | 416 | 424 | 432 | 440 | 448 | 456 | 464 | 472 |
| 543 | 480 | 488 | 496 | 504 | 512 | 520 | 528 | 536 | 544 | 552 |
| 544 | 560 | 568 | 576 | 584 | 592 | 600 | 608 | 616 | 624 | 632 |
| 545 | 640 | 648 | 656 | 664 | 672 | 679 | 687 | 695 | 703 | 711 |
| 546 | 719 | 727 | 735 | 743 | 751 | 759 | 767 | 775 | 783 | 791 |
| 547 | 799 | 807 | 815 | 823 | 830 | 838 | 846 | 854 | 862 | 870 |
| 548 | 878 | 886 | 894 | 902 | 910 | 918 | 926 | 933 | 941 | 949 |
| 549 | 957 | 965 | 973 | 981 | 989 | 997 | *005 | *013 | *020 | *028 |
| **550** | 74 036 | 044 | 052 | 060 | 068 | 076 | 084 | 092 | 099 | 107 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 9 |
|---|---|
| 1 | 0.9 |
| 2 | 1.8 |
| 3 | 2.7 |
| 4 | 3.6 |
| 5 | 4.5 |
| 6 | 5.4 |
| 7 | 6.3 |
| 8 | 7.2 |
| 9 | 8.1 |

| | 8 |
|---|---|
| 1 | 0.8 |
| 2 | 1.6 |
| 3 | 2.4 |
| 4 | 3.2 |
| 5 | 4.0 |
| 6 | 4.8 |
| 7 | 5.6 |
| 8 | 6.4 |
| 9 | 7.2 |

| | 7 |
|---|---|
| 1 | 0.7 |
| 2 | 1.4 |
| 3 | 2.1 |
| 4 | 2.8 |
| 5 | 3.5 |
| 6 | 4.2 |
| 7 | 4.9 |
| 8 | 5.6 |
| 9 | 6.3 |

P. P.

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **550** | 74 036 | 044 | 052 | 060 | 068 | 076 | 084 | 092 | 099 | 107 |
| 551 | 115 | 123 | 131 | 139 | 147 | 155 | 162 | 170 | 178 | 186 |
| 552 | 194 | 202 | 210 | 218 | 225 | 233 | 241 | 249 | 257 | 265 |
| 553 | 273 | 280 | 288 | 296 | 304 | 312 | 320 | 327 | 335 | 343 |
| 554 | 351 | 359 | 367 | 374 | 382 | 390 | 398 | 406 | 414 | 421 |
| 555 | 429 | 437 | 445 | 453 | 461 | 468 | 476 | 484 | 492 | 500 |
| 556 | 507 | 515 | 523 | 531 | 539 | 547 | 554 | 562 | 570 | 578 |
| 557 | 586 | 593 | 601 | 609 | 617 | 624 | 632 | 640 | 648 | 656 |
| 558 | 663 | 671 | 679 | 687 | 695 | 702 | 710 | 718 | 726 | 733 |
| 559 | 741 | 749 | 757 | 764 | 772 | 780 | 788 | 796 | 803 | 811 |
| **560** | 819 | 827 | 834 | 842 | 850 | 858 | 865 | 873 | 881 | 889 |
| 561 | 896 | 904 | 912 | 920 | 927 | 935 | 943 | 950 | 958 | 966 |
| 562 | 974 | 981 | 989 | 997 | *005 | *012 | *020 | *028 | *035 | *043 |
| 563 | 75 051 | 059 | 066 | 074 | 082 | 089 | 097 | 105 | 113 | 120 |
| 564 | 128 | 136 | 143 | 151 | 159 | 166 | 174 | 182 | 189 | 197 |
| 565 | 205 | 213 | 220 | 228 | 236 | 243 | 251 | 259 | 266 | 274 |
| 566 | 282 | 289 | 297 | 305 | 312 | 320 | 328 | 335 | 343 | 351 |
| 567 | 358 | 366 | 374 | 381 | 389 | 397 | 404 | 412 | 420 | 427 |
| 568 | 435 | 442 | 450 | 458 | 465 | 473 | 481 | 488 | 496 | 504 |
| 569 | 511 | 519 | 526 | 534 | 542 | 549 | 557 | 565 | 572 | 580 |
| **570** | 587 | 595 | 603 | 610 | 618 | 626 | 633 | 641 | 648 | 656 |
| 571 | 664 | 671 | 679 | 686 | 694 | 702 | 709 | 717 | 724 | 732 |
| 572 | 740 | 747 | 755 | 762 | 770 | 778 | 785 | 793 | 800 | 808 |
| 573 | 815 | 823 | 831 | 838 | 846 | 853 | 861 | 868 | 876 | 884 |
| 574 | 891 | 899 | 906 | 914 | 921 | 929 | 937 | 944 | 952 | 959 |
| 575 | 967 | 974 | 982 | 989 | 997 | *005 | *012 | *020 | *027 | *035 |
| 576 | 76 042 | 050 | 057 | 065 | 072 | 080 | 087 | 095 | 103 | 110 |
| 577 | 118 | 125 | 133 | 140 | 148 | 155 | 163 | 170 | 178 | 185 |
| 578 | 193 | 200 | 208 | 215 | 223 | 230 | 238 | 245 | 253 | 260 |
| 579 | 268 | 275 | 283 | 290 | 298 | 305 | 313 | 320 | 328 | 335 |
| **580** | 343 | 350 | 358 | 365 | 373 | 380 | 388 | 395 | 403 | 410 |
| 581 | 418 | 425 | 433 | 440 | 448 | 455 | 462 | 470 | 477 | 485 |
| 582 | 492 | 500 | 507 | 515 | 522 | 530 | 537 | 545 | 552 | 559 |
| 583 | 567 | 574 | 582 | 589 | 597 | 604 | 612 | 619 | 626 | 634 |
| 584 | 641 | 649 | 656 | 664 | 671 | 678 | 686 | 693 | 701 | 708 |
| 585 | 716 | 723 | 730 | 738 | 745 | 753 | 760 | 768 | 775 | 782 |
| 586 | 790 | 797 | 805 | 812 | 819 | 827 | 834 | 842 | 849 | 856 |
| 587 | 864 | 871 | 879 | 886 | 893 | 901 | 908 | 916 | 923 | 930 |
| 588 | 938 | 945 | 953 | 960 | 967 | 975 | 982 | 989 | 997 | *004 |
| 589 | 77 012 | 019 | 026 | 034 | 041 | 048 | 056 | 063 | 070 | 078 |
| **590** | 085 | 093 | 100 | 107 | 115 | 122 | 129 | 137 | 144 | 151 |
| 591 | 159 | 166 | 173 | 181 | 188 | 195 | 203 | 210 | 217 | 225 |
| 592 | 232 | 240 | 247 | 254 | 262 | 269 | 276 | 283 | 291 | 298 |
| 593 | 305 | 313 | 320 | 327 | 335 | 342 | 349 | 357 | 364 | 371 |
| 594 | 379 | 386 | 393 | 401 | 408 | 415 | 422 | 430 | 437 | 444 |
| 595 | 452 | 459 | 466 | 474 | 481 | 488 | 495 | 503 | 510 | 517 |
| 596 | 525 | 532 | 539 | 546 | 554 | 561 | 568 | 576 | 583 | 590 |
| 597 | 597 | 605 | 612 | 619 | 627 | 634 | 641 | 648 | 656 | 663 |
| 598 | 670 | 677 | 685 | 692 | 699 | 706 | 714 | 721 | 728 | 735 |
| 599 | 743 | 750 | 757 | 764 | 772 | 779 | 786 | 793 | 801 | 808 |
| **600** | 815 | 822 | 830 | 837 | 844 | 851 | 859 | 866 | 873 | 880 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 8 |
|---|---|
| 1 | 0.8 |
| 2 | 1.6 |
| 3 | 2.4 |
| 4 | 3.2 |
| 5 | 4.0 |
| 6 | 4.8 |
| 7 | 5.6 |
| 8 | 6.4 |
| 9 | 7.2 |

| | 7 |
|---|---|
| 1 | 0.7 |
| 2 | 1.4 |
| 3 | 2.1 |
| 4 | 2.8 |
| 5 | 3.5 |
| 6 | 4.2 |
| 7 | 4.9 |
| 8 | 5.6 |
| 9 | 6.3 |

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **600** | 77 815 | 822 | 830 | 837 | 844 | 851 | 859 | 866 | 873 | 880 |
| 601 | 887 | 895 | 902 | 909 | 916 | 924 | 931 | 938 | 945 | 952 |
| 602 | 960 | 967 | 974 | 981 | 988 | 996 | *003 | *010 | *017 | *025 |
| 603 | 78 032 | 039 | 046 | 053 | 061 | 068 | 075 | 082 | 089 | 097 |
| 604 | 104 | 111 | 118 | 125 | 132 | 140 | 147 | 154 | 161 | 168 |
| 605 | 176 | 183 | 190 | 197 | 204 | 211 | 219 | 226 | 233 | 240 |
| 606 | 247 | 254 | 262 | 269 | 276 | 283 | 290 | 297 | 305 | 312 |
| 607 | 319 | 326 | 333 | 340 | 347 | 355 | 362 | 369 | 376 | 383 |
| 608 | 390 | 398 | 405 | 412 | 419 | 426 | 433 | 440 | 447 | 455 |
| 609 | 462 | 469 | 476 | 483 | 490 | 497 | 504 | 512 | 519 | 526 |
| **610** | 533 | 540 | 547 | 554 | 561 | 569 | 576 | 583 | 590 | 597 |
| 611 | 604 | 611 | 618 | 625 | 633 | 640 | 647 | 654 | 661 | 668 |
| 612 | 675 | 682 | 689 | 696 | 704 | 711 | 718 | 725 | 732 | 739 |
| 613 | 746 | 753 | 760 | 767 | 774 | 781 | 789 | 796 | 803 | 810 |
| 614 | 817 | 824 | 831 | 838 | 845 | 852 | 859 | 866 | 873 | 880 |
| 615 | 888 | 895 | 902 | 909 | 916 | 923 | 930 | 937 | 944 | 951 |
| 616 | 958 | 965 | 972 | 979 | 986 | 993 | *000 | *007 | *014 | *021 |
| 617 | 79 029 | 036 | 043 | 050 | 057 | 064 | 071 | 078 | 085 | 092 |
| 618 | 099 | 106 | 113 | 120 | 127 | 134 | 141 | 148 | 155 | 162 |
| 619 | 169 | 176 | 183 | 190 | 197 | 204 | 211 | 218 | 225 | 232 |
| **620** | 239 | 246 | 253 | 260 | 267 | 274 | 281 | 288 | 295 | 302 |
| 621 | 309 | 316 | 323 | 330 | 337 | 344 | 351 | 358 | 365 | 372 |
| 622 | 379 | 386 | 393 | 400 | 407 | 414 | 421 | 428 | 435 | 442 |
| 623 | 449 | 456 | 463 | 470 | 477 | 484 | 491 | 498 | 505 | 511 |
| 624 | 518 | 525 | 532 | 539 | 546 | 553 | 560 | 567 | 574 | 581 |
| 625 | 588 | 595 | 602 | 609 | 616 | 623 | 630 | 637 | 644 | 650 |
| 626 | 657 | 664 | 671 | 678 | 685 | 692 | 699 | 706 | 713 | 720 |
| 627 | 727 | 734 | 741 | 748 | 754 | 761 | 768 | 775 | 782 | 789 |
| 628 | 796 | 803 | 810 | 817 | 824 | 831 | 837 | 844 | 851 | 858 |
| 629 | 865 | 872 | 879 | 886 | 893 | 900 | 906 | 913 | 920 | 927 |
| **630** | 934 | 941 | 948 | 955 | 962 | 969 | 975 | 982 | 989 | 996 |
| 631 | 80 003 | 010 | 017 | 024 | 030 | 037 | 044 | 051 | 058 | 065 |
| 632 | 072 | 079 | 085 | 092 | 099 | 106 | 113 | 120 | 127 | 134 |
| 633 | 140 | 147 | 154 | 161 | 168 | 175 | 182 | 188 | 195 | 202 |
| 634 | 209 | 216 | 223 | 229 | 236 | 243 | 250 | 257 | 264 | 271 |
| 635 | 277 | 284 | 291 | 298 | 305 | 312 | 318 | 325 | 332 | 339 |
| 636 | 346 | 353 | 359 | 366 | 373 | 380 | 387 | 393 | 400 | 407 |
| 637 | 414 | 421 | 428 | 434 | 441 | 448 | 455 | 462 | 468 | 475 |
| 638 | 482 | 489 | 496 | 502 | 509 | 516 | 523 | 530 | 536 | 543 |
| 639 | 550 | 557 | 564 | 570 | 577 | 584 | 591 | 598 | 604 | 611 |
| **640** | 618 | 625 | 632 | 638 | 645 | 652 | 659 | 665 | 672 | 679 |
| 641 | 686 | 693 | 699 | 706 | 713 | 720 | 726 | 733 | 740 | 747 |
| 642 | 754 | 760 | 767 | 774 | 781 | 787 | 794 | 801 | 808 | 814 |
| 643 | 821 | 828 | 835 | 841 | 848 | 855 | 862 | 868 | 875 | 882 |
| 644 | 889 | 895 | 902 | 909 | 916 | 922 | 929 | 936 | 943 | 949 |
| 645 | 956 | 963 | 969 | 976 | 983 | 990 | 996 | *003 | *010 | *017 |
| 646 | 81 023 | 030 | 037 | 043 | 050 | 057 | 064 | 070 | 077 | 084 |
| 647 | 090 | 097 | 104 | 111 | 117 | 124 | 131 | 137 | 144 | 151 |
| 648 | 158 | 164 | 171 | 178 | 184 | 191 | 198 | 204 | 211 | 218 |
| 649 | 224 | 231 | 238 | 245 | 251 | 258 | 265 | 271 | 278 | 285 |
| **650** | 291 | 298 | 305 | 311 | 318 | 325 | 331 | 338 | 345 | 351 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | **8** |
|---|---|
| 1 | 0.8 |
| 2 | 1.6 |
| 3 | 2.4 |
| 4 | 3.2 |
| 5 | 4.0 |
| 6 | 4.8 |
| 7 | 5.6 |
| 8 | 6.4 |
| 9 | 7.2 |

| | **7** |
|---|---|
| 1 | 0.7 |
| 2 | 1.4 |
| 3 | 2.1 |
| 4 | 2.8 |
| 5 | 3.5 |
| 6 | 4.2 |
| 7 | 4.9 |
| 8 | 5.6 |
| 9 | 6.3 |

| | **6** |
|---|---|
| 1 | 0.6 |
| 2 | 1.2 |
| 3 | 1.8 |
| 4 | 2.4 |
| 5 | 3.0 |
| 6 | 3.6 |
| 7 | 4.2 |
| 8 | 4.8 |
| 9 | 5.4 |

P. P.

| L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 81 291 | 298 | 305 | 311 | 318 | 325 | 331 | 338 | 345 | 351 |
| 358 | 365 | 371 | 378 | 385 | 391 | 398 | 405 | 411 | 418 |
| 425 | 431 | 438 | 445 | 451 | 458 | 465 | 471 | 478 | 485 |
| 491 | 498 | 505 | 511 | 518 | 525 | 531 | 538 | 544 | 551 |
| 558 | 564 | 571 | 578 | 584 | 591 | 598 | 604 | 611 | 617 |
| 624 | 631 | 637 | 644 | 651 | 657 | 664 | 671 | 677 | 684 |
| 690 | 697 | 704 | 710 | 717 | 723 | 730 | 737 | 743 | 750 |
| 757 | 763 | 770 | 776 | 783 | 790 | 796 | 803 | 809 | 816 |
| 823 | 829 | 836 | 842 | 849 | 856 | 862 | 869 | 875 | 882 |
| 889 | 895 | 902 | 908 | 915 | 921 | 928 | 935 | 941 | 948 |
| 954 | 961 | 968 | 974 | 981 | 987 | 994 | *000 | *007 | *014 |
| 82 020 | 027 | 033 | 040 | 046 | 053 | 060 | 066 | 073 | 079 |
| 086 | 092 | 099 | 105 | 112 | 119 | 125 | 132 | 138 | 145 |
| 151 | 158 | 164 | 171 | 178 | 184 | 191 | 197 | 204 | 210 |
| 217 | 223 | 230 | 236 | 243 | 249 | 256 | 263 | 269 | 276 |
| 282 | 289 | 295 | 302 | 308 | 315 | 321 | 328 | 334 | 341 |
| 347 | 354 | 360 | 367 | 373 | 380 | 387 | 393 | 400 | 406 |
| 413 | 419 | 426 | 432 | 439 | 445 | 452 | 458 | 465 | 471 |
| 478 | 484 | 491 | 497 | 504 | 510 | 517 | 523 | 530 | 536 |
| 543 | 549 | 556 | 562 | 569 | 575 | 582 | 588 | 595 | 601 |
| 607 | 614 | 620 | 627 | 633 | 640 | 646 | 653 | 659 | 666 |
| 672 | 679 | 685 | 692 | 698 | 705 | 711 | 718 | 724 | 730 |
| 737 | 743 | 750 | 756 | 763 | 769 | 776 | 782 | 789 | 795 |
| 802 | 808 | 814 | 821 | 827 | 834 | 840 | 847 | 853 | 860 |
| 866 | 872 | 879 | 885 | 892 | 898 | 905 | 911 | 918 | 924 |
| 930 | 937 | 943 | 950 | 956 | 963 | 969 | 975 | 982 | 988 |
| 995 | *001 | *008 | *014 | *020 | *027 | *033 | *040 | *046 | *052 |
| 83 059 | 065 | 072 | 078 | 085 | 091 | 097 | 104 | 110 | 117 |
| 123 | 129 | 136 | 142 | 149 | 155 | 161 | 168 | 174 | 181 |
| 187 | 193 | 200 | 206 | 213 | 219 | 225 | 232 | 238 | 245 |
| 251 | 257 | 264 | 270 | 276 | 283 | 289 | 296 | 302 | 308 |
| 315 | 321 | 327 | 334 | 340 | 347 | 353 | 359 | 366 | 372 |
| 378 | 385 | 391 | 398 | 404 | 410 | 417 | 423 | 429 | 436 |
| 442 | 448 | 455 | 461 | 467 | 474 | 480 | 487 | 493 | 499 |
| 506 | 512 | 518 | 525 | 531 | 537 | 544 | 550 | 556 | 563 |
| 569 | 575 | 582 | 588 | 594 | 601 | 607 | 613 | 620 | 626 |
| 632 | 639 | 645 | 651 | 658 | 664 | 670 | 677 | 683 | 689 |
| 696 | 702 | 708 | 715 | 721 | 727 | 734 | 740 | 746 | 753 |
| 759 | 765 | 771 | 778 | 784 | 790 | 797 | 803 | 809 | 816 |
| 822 | 828 | 835 | 841 | 847 | 853 | 860 | 866 | 872 | 879 |
| 885 | 891 | 897 | 904 | 910 | 916 | 923 | 929 | 935 | 942 |
| 948 | 954 | 960 | 967 | 973 | 979 | 985 | 992 | 998 | *004 |
| 84 011 | 017 | 023 | 029 | 036 | 042 | 048 | 055 | 061 | 067 |
| 073 | 080 | 086 | 092 | 098 | 105 | 111 | 117 | 123 | 130 |
| 136 | 142 | 148 | 155 | 161 | 167 | 173 | 180 | 186 | 192 |
| 198 | 205 | 211 | 217 | 223 | 230 | 236 | 242 | 248 | 255 |
| 261 | 267 | 273 | 280 | 286 | 292 | 298 | 305 | 311 | 317 |
| 323 | 330 | 336 | 342 | 348 | 354 | 361 | 367 | 373 | 379 |
| 386 | 392 | 398 | 404 | 410 | 417 | 423 | 429 | 435 | 442 |
| 448 | 454 | 460 | 466 | 473 | 479 | 485 | 491 | 497 | 504 |
| 510 | 516 | 522 | 528 | 535 | 541 | 547 | 553 | 559 | 566 |
| L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 7 |
|---|---|
| 1 | 0.7 |
| 2 | 1.4 |
| 3 | 2.1 |
| 4 | 2.8 |
| 5 | 3.5 |
| 6 | 4.2 |
| 7 | 4.9 |
| 8 | 5.6 |
| 9 | 6.3 |

| | 6 |
|---|---|
| 1 | 0.6 |
| 2 | 1.2 |
| 3 | 1.8 |
| 4 | 2.4 |
| 5 | 3.0 |
| 6 | 3.6 |
| 7 | 4.2 |
| 8 | 4.8 |
| 9 | 5.4 |

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **700** | 84 510 | 516 | 522 | 528 | 535 | 541 | 547 | 553 | 559 | 566 |
| 701 | 572 | 578 | 584 | 590 | 597 | 603 | 609 | 615 | 621 | 628 |
| 702 | 634 | 640 | 646 | 652 | 658 | 665 | 671 | 677 | 683 | 689 |
| 703 | 696 | 702 | 708 | 714 | 720 | 726 | 733 | 739 | 745 | 751 |
| 704 | 757 | 763 | 770 | 776 | 782 | 788 | 794 | 800 | 807 | 813 |
| 705 | 819 | 825 | 831 | 837 | 844 | 850 | 856 | 862 | 868 | 874 |
| 706 | 880 | 887 | 893 | 899 | 905 | 911 | 917 | 924 | 930 | 936 |
| 707 | 942 | 948 | 954 | 960 | 967 | 973 | 979 | 985 | 991 | 997 |
| 708 | 85 003 | 009 | 016 | 022 | 028 | 034 | 040 | 046 | 052 | 058 |
| 709 | 065 | 071 | 077 | 083 | 089 | 095 | 101 | 107 | 114 | 120 |
| **710** | 126 | 132 | 138 | 144 | 150 | 156 | 163 | 169 | 175 | 181 |
| 711 | 187 | 193 | 199 | 205 | 211 | 217 | 224 | 230 | 236 | 242 |
| 712 | 248 | 254 | 260 | 266 | 272 | 278 | 285 | 291 | 297 | 303 |
| 713 | 309 | 315 | 321 | 327 | 333 | 339 | 345 | 352 | 358 | 364 |
| 714 | 370 | 376 | 382 | 388 | 394 | 400 | 406 | 412 | 418 | 425 |
| 715 | 431 | 437 | 443 | 449 | 455 | 461 | 467 | 473 | 479 | 485 |
| 716 | 491 | 497 | 503 | 509 | 516 | 522 | 528 | 534 | 540 | 546 |
| 717 | 552 | 558 | 564 | 570 | 576 | 582 | 588 | 594 | 600 | 606 |
| 718 | 612 | 618 | 625 | 631 | 637 | 643 | 649 | 655 | 661 | 667 |
| 719 | 673 | 679 | 685 | 691 | 697 | 703 | 709 | 715 | 721 | 727 |
| **720** | 733 | 739 | 745 | 751 | 757 | 763 | 769 | 775 | 781 | 788 |
| 721 | 794 | 800 | 806 | 812 | 818 | 824 | 830 | 836 | 842 | 848 |
| 722 | 854 | 860 | 866 | 872 | 878 | 884 | 890 | 896 | 902 | 908 |
| 723 | 914 | 920 | 926 | 932 | 938 | 944 | 950 | 956 | 962 | 968 |
| 724 | 974 | 980 | 986 | 992 | 998 | *004 | *010 | *016 | *022 | *028 |
| 725 | 86 034 | 040 | 046 | 052 | 058 | 064 | 070 | 076 | 082 | 088 |
| 726 | 094 | 100 | 106 | 112 | 118 | 124 | 130 | 136 | 141 | 147 |
| 727 | 153 | 159 | 165 | 171 | 177 | 183 | 189 | 195 | 201 | 207 |
| 728 | 213 | 219 | 225 | 231 | 237 | 243 | 249 | 255 | 261 | 267 |
| 729 | 273 | 279 | 285 | 291 | 297 | 303 | 308 | 314 | 320 | 326 |
| **730** | 332 | 338 | 344 | 350 | 356 | 362 | 368 | 374 | 380 | 386 |
| 731 | 392 | 398 | 404 | 410 | 415 | 421 | 427 | 433 | 439 | 445 |
| 732 | 451 | 457 | 463 | 469 | 475 | 481 | 487 | 493 | 499 | 504 |
| 733 | 510 | 516 | 522 | 528 | 534 | 540 | 546 | 552 | 558 | 564 |
| 734 | 570 | 576 | 581 | 587 | 593 | 599 | 605 | 611 | 617 | 623 |
| 735 | 629 | 635 | 641 | 646 | 652 | 658 | 664 | 670 | 676 | 682 |
| 736 | 688 | 694 | 700 | 705 | 711 | 717 | 723 | 729 | 735 | 741 |
| 737 | 747 | 753 | 759 | 764 | 770 | 776 | 782 | 788 | 794 | 800 |
| 738 | 806 | 812 | 817 | 823 | 829 | 835 | 841 | 847 | 853 | 859 |
| 739 | 864 | 870 | 876 | 882 | 888 | 894 | 900 | 906 | 911 | 917 |
| **740** | 923 | 929 | 935 | 941 | 947 | 953 | 958 | 964 | 970 | 976 |
| 741 | 982 | 988 | 994 | 999 | *005 | *011 | *017 | *023 | *029 | *035 |
| 742 | 87 040 | 046 | 052 | 058 | 064 | 070 | 075 | 081 | 087 | 093 |
| 743 | 099 | 105 | 111 | 116 | 122 | 128 | 134 | 140 | 146 | 151 |
| 744 | 157 | 163 | 169 | 175 | 181 | 186 | 192 | 198 | 204 | 210 |
| 745 | 216 | 221 | 227 | 233 | 239 | 245 | 251 | 256 | 262 | 268 |
| 746 | 274 | 280 | 286 | 291 | 297 | 303 | 309 | 315 | 320 | 326 |
| 747 | 332 | 338 | 344 | 349 | 355 | 361 | 367 | 373 | 379 | 384 |
| 748 | 390 | 396 | 402 | 408 | 413 | 419 | 425 | 431 | 437 | 442 |
| 749 | 448 | 454 | 460 | 466 | 471 | 477 | 483 | 489 | 495 | 500 |
| **750** | 506 | 512 | 518 | 523 | 529 | 535 | 541 | 547 | 552 | 558 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 7 | 6 | 5 |
|---|---|---|---|
| 1 | 0.7 | 0.6 | 0.5 |
| 2 | 1.4 | 1.2 | 1.0 |
| 3 | 2.1 | 1.8 | 1.5 |
| 4 | 2.8 | 2.4 | 2.0 |
| 5 | 3.5 | 3.0 | 2.5 |
| 6 | 4.2 | 3.6 | 3.0 |
| 7 | 4.9 | 4.2 | 3.5 |
| 8 | 5.6 | 4.8 | 4.0 |
| 9 | 6.3 | 5.4 | 4.5 |

| L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 87 506 | 512 | 518 | 523 | 529 | 535 | 541 | 547 | 552 | 558 |
| 564 | 570 | 576 | 581 | 587 | 593 | 599 | 604 | 610 | 616 |
| 622 | 628 | 633 | 639 | 645 | 651 | 656 | 662 | 668 | 674 |
| 679 | 685 | 691 | 697 | 703 | 708 | 714 | 720 | 726 | 731 |
| 737 | 743 | 749 | 754 | 760 | 766 | 772 | 777 | 783 | 789 |
| 795 | 800 | 806 | 812 | 818 | 823 | 829 | 835 | 841 | 846 |
| 852 | 858 | 864 | 869 | 875 | 881 | 887 | 892 | 898 | 904 |
| 910 | 915 | 921 | 927 | 933 | 938 | 944 | 950 | 955 | 961 |
| 967 | 973 | 978 | 984 | 990 | 996 | *001 | *007 | *013 | *018 |
| 88 024 | 030 | 036 | 041 | 047 | 053 | 058 | 064 | 070 | 076 |
| 081 | 087 | 093 | 098 | 104 | 110 | 116 | 121 | 127 | 133 |
| 138 | 144 | 150 | 156 | 161 | 167 | 173 | 178 | 184 | 190 |
| 195 | 201 | 207 | 213 | 218 | 224 | 230 | 235 | 241 | 247 |
| 252 | 258 | 264 | 270 | 275 | 281 | 287 | 292 | 298 | 304 |
| 309 | 315 | 321 | 326 | 332 | 338 | 343 | 349 | 355 | 360 |
| 366 | 372 | 377 | 383 | 389 | 395 | 400 | 406 | 412 | 417 |
| 423 | 429 | 434 | 440 | 446 | 451 | 457 | 463 | 468 | 474 |
| 480 | 485 | 491 | 497 | 502 | 508 | 513 | 519 | 525 | 530 |
| 536 | 542 | 547 | 553 | 559 | 564 | 570 | 576 | 581 | 587 |
| 593 | 598 | 604 | 610 | 615 | 621 | 627 | 632 | 638 | 643 |
| 649 | 655 | 660 | 666 | 672 | 677 | 683 | 689 | 694 | 700 |
| 705 | 711 | 717 | 722 | 728 | 734 | 739 | 745 | 750 | 756 |
| 762 | 767 | 773 | 779 | 784 | 790 | 795 | 801 | 807 | 812 |
| 818 | 824 | 829 | 835 | 840 | 846 | 852 | 857 | 863 | 868 |
| 874 | 880 | 885 | 891 | 897 | 902 | 908 | 913 | 919 | 925 |
| 930 | 936 | 941 | 947 | 953 | 958 | 964 | 969 | 975 | 981 |
| 986 | 992 | 997 | *003 | *009 | *014 | *020 | *025 | *031 | *037 |
| 89 042 | 048 | 053 | 059 | 064 | 070 | 076 | 081 | 087 | 092 |
| 098 | 104 | 109 | 115 | 120 | 126 | 131 | 137 | 143 | 148 |
| 154 | 159 | 165 | 170 | 176 | 182 | 187 | 193 | 198 | 204 |
| 209 | 215 | 221 | 226 | 232 | 237 | 243 | 248 | 254 | 260 |
| 265 | 271 | 276 | 282 | 287 | 293 | 298 | 304 | 310 | 315 |
| 321 | 326 | 332 | 337 | 343 | 348 | 354 | 360 | 365 | 371 |
| 376 | 382 | 387 | 393 | 398 | 404 | 409 | 415 | 421 | 426 |
| 432 | 437 | 443 | 448 | 454 | 459 | 465 | 470 | 476 | 481 |
| 487 | 492 | 498 | 504 | 509 | 515 | 520 | 526 | 531 | 537 |
| 542 | 548 | 553 | 559 | 564 | 570 | 575 | 581 | 586 | 592 |
| 597 | 603 | 609 | 614 | 620 | 625 | 631 | 636 | 642 | 647 |
| 653 | 658 | 664 | 669 | 675 | 680 | 686 | 691 | 697 | 702 |
| 708 | 713 | 719 | 724 | 730 | 735 | 741 | 746 | 752 | 757 |
| 763 | 768 | 774 | 779 | 785 | 790 | 796 | 801 | 807 | 812 |
| 818 | 823 | 829 | 834 | 840 | 845 | 851 | 856 | 862 | 867 |
| 873 | 878 | 883 | 889 | 894 | 900 | 905 | 911 | 916 | 922 |
| 927 | 933 | 938 | 944 | 949 | 955 | 960 | 966 | 971 | 977 |
| 982 | 988 | 993 | 998 | *004 | *009 | *015 | *020 | *026 | *031 |
| 90 037 | 042 | 048 | 053 | 059 | 064 | 069 | 075 | 080 | 086 |
| 091 | 097 | 102 | 108 | 113 | 119 | 124 | 129 | 135 | 140 |
| 146 | 151 | 157 | 162 | 168 | 173 | 179 | 184 | 189 | 195 |
| 200 | 206 | 211 | 217 | 222 | 227 | 233 | 238 | 244 | 249 |
| 255 | 260 | 266 | 271 | 276 | 282 | 287 | 293 | 298 | 304 |
| 309 | 314 | 320 | 325 | 331 | 336 | 342 | 347 | 352 | 358 |
| L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 6 |
|---|---|
| 1 | 0.6 |
| 2 | 1.2 |
| 3 | 1.8 |
| 4 | 2.4 |
| 5 | 3.0 |
| 6 | 3.6 |
| 7 | 4.2 |
| 8 | 4.8 |
| 9 | 5.4 |

| | 5 |
|---|---|
| 1 | 0.5 |
| 2 | 1.0 |
| 3 | 1.5 |
| 4 | 2.0 |
| 5 | 2.5 |
| 6 | 3.0 |
| 7 | 3.5 |
| 8 | 4.0 |
| 9 | 4.5 |

P. P.

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **800** | 90 309 | 314 | 320 | 325 | 331 | 336 | 342 | 347 | 352 | 358 |
| 801 | 363 | 369 | 374 | 380 | 385 | 390 | 396 | 401 | 407 | 412 |
| 802 | 417 | 423 | 428 | 434 | 439 | 445 | 450 | 455 | 461 | 466 |
| 803 | 472 | 477 | 482 | 488 | 493 | 499 | 504 | 509 | 515 | 520 |
| 804 | 526 | 531 | 536 | 542 | 547 | 553 | 558 | 563 | 569 | 574 |
| 805 | 580 | 585 | 590 | 596 | 601 | 607 | 612 | 617 | 623 | 628 |
| 806 | 634 | 639 | 644 | 650 | 655 | 660 | 666 | 671 | 677 | 682 |
| 807 | 687 | 693 | 698 | 703 | 709 | 714 | 720 | 725 | 730 | 736 |
| 808 | 741 | 747 | 752 | 757 | 763 | 768 | 773 | 779 | 784 | 789 |
| 809 | 795 | 800 | 806 | 811 | 816 | 822 | 827 | 832 | 838 | 843 |
| **810** | 849 | 854 | 859 | 865 | 870 | 875 | 881 | 886 | 891 | 897 |
| 811 | 902 | 907 | 913 | 918 | 924 | 929 | 934 | 940 | 945 | 950 |
| 812 | 956 | 961 | 966 | 972 | 977 | 982 | 988 | 993 | 998 | *004 |
| 813 | 91 009 | 014 | 020 | 025 | 030 | 036 | 041 | 046 | 052 | 057 |
| 814 | 062 | 068 | 073 | 078 | 084 | 089 | 094 | 100 | 105 | 110 |
| 815 | 116 | 121 | 126 | 132 | 137 | 142 | 148 | 153 | 158 | 164 |
| 816 | 169 | 174 | 180 | 185 | 190 | 196 | 201 | 206 | 212 | 217 |
| 817 | 222 | 228 | 233 | 238 | 243 | 249 | 254 | 259 | 265 | 270 |
| 818 | 275 | 281 | 286 | 291 | 297 | 302 | 307 | 312 | 318 | 323 |
| 819 | 328 | 334 | 339 | 344 | 350 | 355 | 360 | 365 | 371 | 376 |
| **820** | 381 | 387 | 392 | 397 | 403 | 408 | 413 | 418 | 424 | 429 |
| 821 | 434 | 440 | 445 | 450 | 455 | 461 | 466 | 471 | 477 | 482 |
| 822 | 487 | 492 | 498 | 503 | 508 | 514 | 519 | 524 | 529 | 535 |
| 823 | 540 | 545 | 551 | 556 | 561 | 566 | 572 | 577 | 582 | 587 |
| 824 | 593 | 598 | 603 | 609 | 614 | 619 | 624 | 630 | 635 | 640 |
| 825 | 645 | 651 | 656 | 661 | 666 | 672 | 677 | 682 | 687 | 693 |
| 826 | 698 | 703 | 709 | 714 | 719 | 724 | 730 | 735 | 740 | 745 |
| 827 | 751 | 756 | 761 | 766 | 772 | 777 | 782 | 787 | 793 | 798 |
| 828 | 803 | 808 | 814 | 819 | 824 | 829 | 834 | 840 | 845 | 850 |
| 829 | 855 | 861 | 866 | 871 | 876 | 882 | 887 | 892 | 897 | 903 |
| **830** | 908 | 913 | 918 | 924 | 929 | 934 | 939 | 944 | 950 | 955 |
| 831 | 960 | 965 | 971 | 976 | 981 | 986 | 991 | 997 | *002 | *007 |
| 832 | 92 012 | 018 | 023 | 028 | 033 | 038 | 044 | 049 | 054 | 059 |
| 833 | 065 | 070 | 075 | 080 | 085 | 091 | 096 | 101 | 106 | 111 |
| 834 | 117 | 122 | 127 | 132 | 137 | 143 | 148 | 153 | 158 | 163 |
| 835 | 169 | 174 | 179 | 184 | 189 | 195 | 200 | 205 | 210 | 215 |
| 836 | 221 | 226 | 231 | 236 | 241 | 247 | 252 | 257 | 262 | 267 |
| 837 | 273 | 278 | 283 | 288 | 293 | 298 | 304 | 309 | 314 | 319 |
| 838 | 324 | 330 | 335 | 340 | 345 | 350 | 355 | 361 | 366 | 371 |
| 839 | 376 | 381 | 387 | 392 | 397 | 402 | 407 | 412 | 418 | 423 |
| **840** | 428 | 433 | 438 | 443 | 449 | 454 | 459 | 464 | 469 | 474 |
| 841 | 480 | 485 | 490 | 495 | 500 | 505 | 511 | 516 | 521 | 526 |
| 842 | 531 | 536 | 542 | 547 | 552 | 557 | 562 | 567 | 572 | 578 |
| 843 | 583 | 588 | 593 | 598 | 603 | 609 | 614 | 619 | 624 | 629 |
| 844 | 634 | 639 | 645 | 650 | 655 | 660 | 665 | 670 | 675 | 681 |
| 845 | 686 | 691 | 696 | 701 | 706 | 711 | 716 | 722 | 727 | 732 |
| 846 | 737 | 742 | 747 | 752 | 758 | 763 | 768 | 773 | 778 | 783 |
| 847 | 788 | 793 | 799 | 804 | 809 | 814 | 819 | 824 | 829 | 834 |
| 848 | 840 | 845 | 850 | 855 | 860 | 865 | 870 | 875 | 881 | 886 |
| 849 | 891 | 896 | 901 | 906 | 911 | 916 | 921 | 927 | 932 | 937 |
| **850** | 942 | 947 | 952 | 957 | 962 | 967 | 973 | 978 | 983 | 988 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 6 |
|---|---|
| 1 | 0.6 |
| 2 | 1.2 |
| 3 | 1.8 |
| 4 | 2.4 |
| 5 | 3.0 |
| 6 | 3.6 |
| 7 | 4.2 |
| 8 | 4.8 |
| 9 | 5.4 |

| | 5 |
|---|---|
| 1 | 0.5 |
| 2 | 1.0 |
| 3 | 1.5 |
| 4 | 2.0 |
| 5 | 2.5 |
| 6 | 3.0 |
| 7 | 3.5 |
| 8 | 4.0 |
| 9 | 4.5 |

P. P.

| L. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 942 | 947 | 952 | 957 | 962 | 967 | 973 | 978 | 983 | 988 |
| | 993 | 998 | *003 | *008 | *013 | *018 | *024 | *029 | *034 | *039 |
| 93 | 044 | 049 | 054 | 059 | 064 | 069 | 075 | 080 | 085 | 090 |
| | 095 | 100 | 105 | 110 | 115 | 120 | 125 | 131 | 136 | 141 |
| | 146 | 151 | 156 | 161 | 166 | 171 | 176 | 181 | 186 | 192 |
| | 197 | 202 | 207 | 212 | 217 | 222 | 227 | 232 | 237 | 242 |
| | 247 | 252 | 258 | 263 | 268 | 273 | 278 | 283 | 288 | 293 |
| | 298 | 303 | 308 | 313 | 318 | 323 | 328 | 334 | 339 | 344 |
| | 349 | 354 | 359 | 364 | 369 | 374 | 379 | 384 | 389 | 394 |
| | 399 | 404 | 409 | 414 | 420 | 425 | 430 | 435 | 440 | 445 |
| | 450 | 455 | 460 | 465 | 470 | 475 | 480 | 485 | 490 | 495 |
| | 500 | 505 | 510 | 515 | 520 | 526 | 531 | 536 | 541 | 546 |
| | 551 | 556 | 561 | 566 | 571 | 576 | 581 | 586 | 591 | 596 |
| | 601 | 606 | 611 | 616 | 621 | 626 | 631 | 636 | 641 | 646 |
| | 651 | 656 | 661 | 666 | 671 | 676 | 682 | 687 | 692 | 697 |
| | 702 | 707 | 712 | 717 | 722 | 727 | 732 | 737 | 742 | 747 |
| | 752 | 757 | 762 | 767 | 772 | 777 | 782 | 787 | 792 | 797 |
| | 802 | 807 | 812 | 817 | 822 | 827 | 832 | 837 | 842 | 847 |
| | 852 | 857 | 862 | 867 | 872 | 877 | 882 | 887 | 892 | 897 |
| | 902 | 907 | 912 | 917 | 922 | 927 | 932 | 937 | 942 | 947 |
| | 952 | 957 | 962 | 967 | 972 | 977 | 982 | 987 | 992 | 997 |
| 94 | 002 | 007 | 012 | 017 | 022 | 027 | 032 | 037 | 042 | 047 |
| | 052 | 057 | 062 | 067 | 072 | 077 | 082 | 086 | 091 | 096 |
| | 101 | 106 | 111 | 116 | 121 | 126 | 131 | 136 | 141 | 146 |
| | 151 | 156 | 161 | 166 | 171 | 176 | 181 | 186 | 191 | 196 |
| | 201 | 206 | 211 | 216 | 221 | 226 | 231 | 236 | 240 | 245 |
| | 250 | 255 | 260 | 265 | 270 | 275 | 280 | 285 | 290 | 295 |
| | 300 | 305 | 310 | 315 | 320 | 325 | 330 | 335 | 340 | 345 |
| | 349 | 354 | 359 | 364 | 369 | 374 | 379 | 384 | 389 | 394 |
| | 399 | 404 | 409 | 414 | 419 | 424 | 429 | 433 | 438 | 443 |
| | 448 | 453 | 458 | 463 | 468 | 473 | 478 | 483 | 488 | 493 |
| | 498 | 503 | 507 | 512 | 517 | 522 | 527 | 532 | 537 | 542 |
| | 547 | 552 | 557 | 562 | 567 | 571 | 576 | 581 | 586 | 591 |
| | 596 | 601 | 606 | 611 | 616 | 621 | 626 | 630 | 635 | 640 |
| | 645 | 650 | 655 | 660 | 665 | 670 | 675 | 680 | 685 | 689 |
| | 694 | 699 | 704 | 709 | 714 | 719 | 724 | 729 | 734 | 738 |
| | 743 | 748 | 753 | 758 | 763 | 768 | 773 | 778 | 783 | 787 |
| | 792 | 797 | 802 | 807 | 812 | 817 | 822 | 827 | 832 | 836 |
| | 841 | 846 | 851 | 856 | 861 | 866 | 871 | 876 | 880 | 885 |
| | 890 | 895 | 900 | 905 | 910 | 915 | 919 | 924 | 929 | 934 |
| | 939 | 944 | 949 | 954 | 959 | 963 | 968 | 973 | 978 | 983 |
| | 988 | 993 | 998 | *002 | *007 | *012 | *017 | *022 | *027 | *032 |
| 95 | 036 | 041 | 046 | 051 | 056 | 061 | 066 | 071 | 075 | 080 |
| | 085 | 090 | 095 | 100 | 105 | 109 | 114 | 119 | 124 | 129 |
| | 134 | 139 | 143 | 148 | 153 | 158 | 163 | 168 | 173 | 177 |
| | 182 | 187 | 192 | 197 | 202 | 207 | 211 | 216 | 221 | 226 |
| | 231 | 236 | 240 | 245 | 250 | 255 | 260 | 265 | 270 | 274 |
| | 279 | 284 | 289 | 294 | 299 | 303 | 308 | 313 | 318 | 323 |
| | 328 | 332 | 337 | 342 | 347 | 352 | 357 | 361 | 366 | 371 |
| | 376 | 381 | 386 | 390 | 395 | 400 | 405 | 410 | 415 | 419 |
| | 424 | 429 | 434 | 439 | 444 | 448 | 453 | 458 | 463 | 468 |
| L. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 6 | 5 | 4 |
|---|---|---|---|
| 1 | 0.6 | 0.5 | 0.4 |
| 2 | 1.2 | 1.0 | 0.8 |
| 3 | 1.8 | 1.5 | 1.2 |
| 4 | 2.4 | 2.0 | 1.6 |
| 5 | 3.0 | 2.5 | 2.0 |
| 6 | 3.6 | 3.0 | 2.4 |
| 7 | 4.2 | 3.5 | 2.8 |
| 8 | 4.8 | 4.0 | 3.2 |
| 9 | 5.4 | 4.5 | 3.6 |

P. P.

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **900** | 95 424 | 429 | 434 | 439 | 444 | 448 | 453 | 458 | 463 | 468 |
| 901 | 472 | 477 | 482 | 487 | 492 | 497 | 501 | 506 | 511 | 516 |
| 902 | 521 | 525 | 530 | 535 | 540 | 545 | 550 | 554 | 559 | 564 |
| 903 | 569 | 574 | 578 | 583 | 588 | 593 | 598 | 602 | 607 | 612 |
| 904 | 617 | 622 | 626 | 631 | 636 | 641 | 646 | 650 | 655 | 660 |
| 905 | 665 | 670 | 674 | 679 | 684 | 689 | 694 | 698 | 703 | 708 |
| 906 | 713 | 718 | 722 | 727 | 732 | 737 | 742 | 746 | 751 | 756 |
| 907 | 761 | 766 | 770 | 775 | 780 | 785 | 789 | 794 | 799 | 804 |
| 908 | 809 | 813 | 818 | 823 | 828 | 832 | 837 | 842 | 847 | 852 |
| 909 | 856 | 861 | 866 | 871 | 875 | 880 | 885 | 890 | 895 | 899 |
| **910** | 904 | 909 | 914 | 918 | 923 | 928 | 933 | 938 | 942 | 947 |
| 911 | 952 | 957 | 961 | 966 | 971 | 976 | 980 | 985 | 990 | 995 |
| 912 | 999 | *004 | *009 | *014 | *019 | *023 | *028 | *033 | *038 | *042 |
| 913 | 96 047 | 052 | 057 | 061 | 066 | 071 | 076 | 080 | 085 | 090 |
| 914 | 095 | 099 | 104 | 109 | 114 | 118 | 123 | 128 | 133 | 137 |
| 915 | 142 | 147 | 152 | 156 | 161 | 166 | 171 | 175 | 180 | 185 |
| 916 | 190 | 194 | 199 | 204 | 209 | 213 | 218 | 223 | 227 | 232 |
| 917 | 237 | 242 | 246 | 251 | 256 | 261 | 265 | 270 | 275 | 280 |
| 918 | 284 | 289 | 294 | 298 | 303 | 308 | 313 | 317 | 322 | 327 |
| 919 | 332 | 336 | 341 | 346 | 350 | 355 | 360 | 365 | 369 | 374 |
| **920** | 379 | 384 | 388 | 393 | 398 | 402 | 407 | 412 | 417 | 421 |
| 921 | 426 | 431 | 435 | 440 | 445 | 450 | 454 | 459 | 464 | 468 |
| 922 | 473 | 478 | 483 | 487 | 492 | 497 | 501 | 506 | 511 | 515 |
| 923 | 520 | 525 | 530 | 534 | 539 | 544 | 548 | 553 | 558 | 562 |
| 924 | 567 | 572 | 577 | 581 | 586 | 591 | 595 | 600 | 605 | 609 |
| 925 | 614 | 619 | 624 | 628 | 633 | 638 | 642 | 647 | 652 | 656 |
| 926 | 661 | 666 | 670 | 675 | 680 | 685 | 689 | 694 | 699 | 703 |
| 927 | 708 | 713 | 717 | 722 | 727 | 731 | 736 | 741 | 745 | 750 |
| 928 | 755 | 759 | 764 | 769 | 774 | 778 | 783 | 788 | 792 | 797 |
| 929 | 802 | 806 | 811 | 816 | 820 | 825 | 830 | 834 | 839 | 844 |
| **930** | 848 | 853 | 858 | 862 | 867 | 872 | 876 | 881 | 886 | 890 |
| 931 | 895 | 900 | 904 | 909 | 914 | 918 | 923 | 928 | 932 | 937 |
| 932 | 942 | 946 | 951 | 956 | 960 | 965 | 970 | 974 | 979 | 984 |
| 933 | 988 | 993 | 997 | *002 | *007 | *011 | *016 | *021 | *025 | *030 |
| 934 | 97 035 | 039 | 044 | 049 | 053 | 058 | 063 | 067 | 072 | 077 |
| 935 | 081 | 086 | 090 | 095 | 100 | 104 | 109 | 114 | 118 | 123 |
| 936 | 128 | 132 | 137 | 142 | 146 | 151 | 155 | 160 | 165 | 169 |
| 937 | 174 | 179 | 183 | 188 | 192 | 197 | 202 | 206 | 211 | 216 |
| 938 | 220 | 225 | 230 | 234 | 239 | 243 | 248 | 253 | 257 | 262 |
| 939 | 267 | 271 | 276 | 280 | 285 | 290 | 294 | 299 | 304 | 308 |
| **940** | 313 | 317 | 322 | 327 | 331 | 336 | 340 | 345 | 350 | 354 |
| 941 | 359 | 364 | 368 | 373 | 377 | 382 | 387 | 391 | 396 | 400 |
| 942 | 405 | 410 | 414 | 419 | 424 | 428 | 433 | 437 | 442 | 447 |
| 943 | 451 | 456 | 460 | 465 | 470 | 474 | 479 | 483 | 488 | 493 |
| 944 | 497 | 502 | 506 | 511 | 516 | 520 | 525 | 529 | 534 | 539 |
| 945 | 543 | 548 | 552 | 557 | 562 | 566 | 571 | 575 | 580 | 585 |
| 946 | 589 | 594 | 598 | 603 | 607 | 612 | 617 | 621 | 626 | 630 |
| 947 | 635 | 640 | 644 | 649 | 653 | 658 | 663 | 667 | 672 | 676 |
| 948 | 681 | 685 | 690 | 695 | 699 | 704 | 708 | 713 | 717 | 722 |
| 949 | 727 | 731 | 736 | 740 | 745 | 749 | 754 | 759 | 763 | 768 |
| **950** | 772 | 777 | 782 | 786 | 791 | 795 | 800 | 804 | 809 | 813 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 5 |
|---|---|
| 1 | 0.5 |
| 2 | 1.0 |
| 3 | 1.5 |
| 4 | 2.0 |
| 5 | 2.5 |
| 6 | 3.0 |
| 7 | 3.5 |
| 8 | 4.0 |
| 9 | 4.5 |

| | 4 |
|---|---|
| 1 | 0.4 |
| 2 | 0.8 |
| 3 | 1.2 |
| 4 | 1.6 |
| 5 | 2.0 |
| 6 | 2.4 |
| 7 | 2.8 |
| 8 | 3.2 |
| 9 | 3.6 |

P. P.

| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **950** | 97 772 | 777 | 782 | 786 | 791 | 795 | 800 | 804 | 809 | 813 |
| 951 | 818 | 823 | 827 | 832 | 836 | 841 | 845 | 850 | 855 | 859 |
| 952 | 864 | 868 | 873 | 877 | 882 | 886 | 891 | 896 | 900 | 905 |
| 953 | 909 | 914 | 918 | 923 | 928 | 932 | 937 | 941 | 946 | 950 |
| 954 | 955 | 959 | 964 | 968 | 973 | 978 | 982 | 987 | 991 | 996 |
| 955 | 98 000 | 005 | 009 | 014 | 019 | 023 | 028 | 032 | 037 | 041 |
| 956 | 046 | 050 | 055 | 059 | 064 | 068 | 073 | 078 | 082 | 087 |
| 957 | 091 | 096 | 100 | 105 | 109 | 114 | 118 | 123 | 127 | 132 |
| 958 | 137 | 141 | 146 | 150 | 155 | 159 | 164 | 168 | 173 | 177 |
| 959 | 182 | 186 | 191 | 195 | 200 | 204 | 209 | 214 | 218 | 223 |
| **960** | 227 | 232 | 236 | 241 | 245 | 250 | 254 | 259 | 263 | 268 |
| 961 | 272 | 277 | 281 | 286 | 290 | 295 | 299 | 304 | 308 | 313 |
| 962 | 318 | 322 | 327 | 331 | 336 | 340 | 345 | 349 | 354 | 358 |
| 963 | 363 | 367 | 372 | 376 | 381 | 385 | 390 | 394 | 399 | 403 |
| 964 | 408 | 412 | 417 | 421 | 426 | 430 | 435 | 439 | 444 | 448 |
| 965 | 453 | 457 | 462 | 466 | 471 | 475 | 480 | 484 | 489 | 493 |
| 966 | 498 | 502 | 507 | 511 | 516 | 520 | 525 | 529 | 534 | 538 |
| 967 | 543 | 547 | 552 | 556 | 561 | 565 | 570 | 574 | 579 | 583 |
| 968 | 588 | 592 | 597 | 601 | 605 | 610 | 614 | 619 | 623 | 628 |
| 969 | 632 | 637 | 641 | 646 | 650 | 655 | 659 | 664 | 668 | 673 |
| **970** | 677 | 682 | 686 | 691 | 695 | 700 | 704 | 709 | 713 | 717 |
| 971 | 722 | 726 | 731 | 735 | 740 | 744 | 749 | 753 | 758 | 762 |
| 972 | 767 | 771 | 776 | 780 | 784 | 789 | 793 | 798 | 802 | 807 |
| 973 | 811 | 816 | 820 | 825 | 829 | 834 | 838 | 843 | 847 | 851 |
| 974 | 856 | 860 | 865 | 869 | 874 | 878 | 883 | 887 | 892 | 896 |
| 975 | 900 | 905 | 909 | 914 | 918 | 923 | 927 | 932 | 936 | 941 |
| 976 | 945 | 949 | 954 | 958 | 963 | 967 | 972 | 976 | 981 | 985 |
| 977 | 989 | 994 | 998 | *003 | *007 | *012 | *016 | *021 | *025 | *029 |
| 978 | 99 034 | 038 | 043 | 047 | 052 | 056 | 061 | 065 | 069 | 074 |
| 979 | 078 | 083 | 087 | 092 | 096 | 100 | 105 | 109 | 114 | 118 |
| **980** | 123 | 127 | 131 | 136 | 140 | 145 | 149 | 154 | 158 | 162 |
| 981 | 167 | 171 | 176 | 180 | 185 | 189 | 193 | 198 | 202 | 207 |
| 982 | 211 | 216 | 220 | 224 | 229 | 233 | 238 | 242 | 247 | 251 |
| 983 | 255 | 260 | 264 | 269 | 273 | 277 | 282 | 286 | 291 | 295 |
| 984 | 300 | 304 | 308 | 313 | 317 | 322 | 326 | 330 | 335 | 339 |
| 985 | 344 | 348 | 352 | 357 | 361 | 366 | 370 | 374 | 379 | 383 |
| 986 | 388 | 392 | 396 | 401 | 405 | 410 | 414 | 419 | 423 | 427 |
| 987 | 432 | 436 | 441 | 445 | 449 | 454 | 458 | 463 | 467 | 471 |
| 988 | 476 | 480 | 484 | 489 | 493 | 498 | 502 | 506 | 511 | 515 |
| 989 | 520 | 524 | 528 | 533 | 537 | 542 | 546 | 550 | 555 | 559 |
| **990** | 564 | 568 | 572 | 577 | 581 | 585 | 590 | 594 | 599 | 603 |
| 991 | 607 | 612 | 616 | 621 | 625 | 629 | 634 | 638 | 642 | 647 |
| 992 | 651 | 656 | 660 | 664 | 669 | 673 | 677 | 682 | 686 | 691 |
| 993 | 695 | 699 | 704 | 708 | 712 | 717 | 721 | 726 | 730 | 734 |
| 994 | 739 | 743 | 747 | 752 | 756 | 760 | 765 | 769 | 774 | 778 |
| 995 | 782 | 787 | 791 | 795 | 800 | 804 | 808 | 813 | 817 | 822 |
| 996 | 826 | 830 | 835 | 839 | 843 | 848 | 852 | 856 | 861 | 865 |
| 997 | 870 | 874 | 878 | 883 | 887 | 891 | 896 | 900 | 904 | 909 |
| 998 | 913 | 917 | 922 | 926 | 930 | 935 | 939 | 944 | 948 | 952 |
| 999 | 957 | 961 | 965 | 970 | 974 | 978 | 983 | 987 | 991 | 996 |
| **1000** | 00 000 | 004 | 009 | 013 | 017 | 022 | 026 | 030 | 035 | 039 |
| N. | L. 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

P. P.

| | 5 |
|---|---|
| 1 | 0.5 |
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| 3 | 1.5 |
| 4 | 2.0 |
| 5 | 2.5 |
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| 8 | 4.0 |
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| | 4 |
|---|---|
| 1 | 0.4 |
| 2 | 0.8 |
| 3 | 1.2 |
| 4 | 1.6 |
| 5 | 2.0 |
| 6 | 2.4 |
| 7 | 2.8 |
| 8 | 3.2 |
| 9 | 3.6 |

P. P.

# TABLES

OF

# NATURAL SINES, COSINES TANGENTS, AND COTANGENTS

GIVING THE VALUES OF THE FUNCTIONS FOR

ALL DEGREES AND MINUTES FROM

0° TO 90°

| ′ | 0° | | 1° | | 2° | | 3° | | 4° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | |
| 0 | .00000 | 1. | .01745 | .99985 | .03490 | .99939 | .05234 | .99863 | .06976 | .99756 | 60 |
| 1 | .00029 | 1. | .01774 | .99984 | .03519 | .99938 | .05263 | .99861 | .07005 | .99754 | 59 |
| 2 | .00058 | 1. | .01803 | .99984 | .03548 | .99937 | .05292 | .99860 | .07034 | .99752 | 58 |
| 3 | .00087 | 1. | .01832 | .99983 | .03577 | .99936 | .05321 | .99858 | .07063 | .99750 | 57 |
| 4 | .00116 | 1. | .01862 | .99983 | .03606 | .99935 | .05350 | .99857 | .07092 | .99748 | 56 |
| 5 | .00145 | 1. | .01891 | .99982 | .03635 | .99934 | .05379 | .99855 | .07121 | .99746 | 55 |
| 6 | .00175 | 1. | .01920 | .99982 | .03664 | .99933 | .05408 | .99854 | .07150 | .99744 | 54 |
| 7 | .00204 | 1. | .01949 | .99981 | .03693 | .99932 | .05437 | .99852 | .07179 | .99742 | 53 |
| 8 | .00233 | 1. | .01978 | .99980 | .03723 | .99931 | .05466 | .99851 | .07208 | .99740 | 52 |
| 9 | .00262 | 1. | .02007 | .99980 | .03752 | .99930 | .05495 | .99849 | .07237 | .99738 | 51 |
| 10 | .00291 | 1. | .02036 | .99979 | .03781 | .99929 | .05524 | .99847 | .07266 | .99736 | 50 |
| 11 | .00320 | .99999 | .02065 | .99979 | .03810 | .99927 | .05553 | .99846 | .07295 | .99734 | 49 |
| 12 | .00349 | .99999 | .02094 | .99978 | .03839 | .99926 | .05582 | .99844 | .07324 | .99731 | 48 |
| 13 | .00378 | .99999 | .02123 | .99977 | .03868 | .99925 | .05611 | .99842 | .07353 | .99729 | 47 |
| 14 | .00407 | .99999 | .02152 | .99977 | .03897 | .99924 | .05640 | .99841 | .07382 | .99727 | 46 |
| 15 | .00436 | .99999 | .02181 | .99976 | .03926 | .99923 | .05669 | .99839 | .07411 | .99725 | 45 |
| 16 | .00465 | .99999 | .02211 | .99976 | .03955 | .99922 | .05698 | .99838 | .07440 | .99723 | 44 |
| 17 | .00495 | .99999 | .02240 | .99975 | .03984 | .99921 | .05727 | .99836 | .07469 | .99721 | 43 |
| 18 | .00524 | .99999 | .02269 | .99974 | .04013 | .99919 | .05756 | .99834 | .07498 | .99719 | 42 |
| 19 | .00553 | .99998 | .02298 | .99974 | .04042 | .99918 | .05785 | .99833 | .07527 | .99716 | 41 |
| 20 | .00582 | .99998 | .02327 | .99973 | .04071 | .99917 | .05814 | .99831 | .07556 | .99714 | 40 |
| 21 | .00611 | .99998 | .02356 | .99972 | .04100 | .99916 | .05844 | .99829 | .07585 | .99712 | 39 |
| 22 | .00640 | .99998 | .02385 | .99972 | .04129 | .99915 | .05873 | .99827 | .07614 | .99710 | 38 |
| 23 | .00669 | .99998 | .02414 | .99971 | .04159 | .99913 | .05902 | .99826 | .07643 | .99708 | 37 |
| 24 | .00698 | .99998 | .02443 | .99970 | .04188 | .99912 | .05931 | .99824 | .07672 | .99705 | 36 |
| 25 | .00727 | .99997 | .02472 | .99969 | .04217 | .99911 | .05960 | .99822 | .07701 | .99703 | 35 |
| 26 | .00756 | .99997 | .02501 | .99969 | .04246 | .99910 | .05989 | .99821 | .07730 | .99701 | 34 |
| 27 | .00785 | .99997 | .02530 | .99968 | .04275 | .99909 | .06018 | .99819 | .07759 | .99699 | 33 |
| 28 | .00814 | .99997 | .02560 | .99967 | .04304 | .99907 | .06047 | .99817 | .07788 | .99696 | 32 |
| 29 | .00844 | .99996 | .02589 | .99966 | .04333 | .99906 | .06076 | .99815 | .07817 | .99694 | 31 |
| 30 | .00873 | .99996 | .02618 | .99966 | .04362 | .99905 | .06105 | .99813 | .07846 | .99692 | 30 |
| 31 | .00902 | .99996 | .02647 | .99965 | .04391 | .99904 | .06134 | .99812 | .07875 | .99689 | 29 |
| 32 | .00931 | .99996 | .02676 | .99964 | .04420 | .99902 | .06163 | .99810 | .07904 | .99687 | 28 |
| 33 | .00960 | .99995 | .02705 | .99963 | .04449 | .99901 | .06192 | .99808 | .07933 | .99685 | 27 |
| 34 | .00989 | .99995 | .02734 | .99963 | .04478 | .99900 | .06221 | .99806 | .07962 | .99682 | 26 |
| 35 | .01018 | .99995 | .02763 | .99962 | .04507 | .99898 | .06250 | .99804 | .07991 | .99680 | 25 |
| 36 | .01047 | .99995 | .02792 | .99961 | .04536 | .99897 | .06279 | .99803 | .08020 | .99678 | 24 |
| 37 | .01076 | .99994 | .02821 | .99960 | .04565 | .99896 | .06308 | .99801 | .08049 | .99676 | 23 |
| 38 | .01105 | .99994 | .02850 | .99959 | .04594 | .99894 | .06337 | .99799 | .08078 | .99673 | 22 |
| 39 | .01134 | .99994 | .02879 | .99959 | .04623 | .99893 | .06366 | .99797 | .08107 | .99671 | 21 |
| 40 | .01164 | .99993 | .02908 | .99958 | .04653 | .99892 | .06395 | .99795 | .08136 | .99668 | 20 |
| 41 | .01193 | .99993 | .02938 | .99957 | .04682 | .99890 | .06424 | .99793 | .08165 | .99666 | 19 |
| 42 | .01222 | .99993 | .02967 | .99956 | .04711 | .99889 | .06453 | .99792 | .08194 | .99664 | 18 |
| 43 | .01251 | .99992 | .02996 | .99955 | .04740 | .99888 | .06482 | .99790 | .08223 | .99661 | 17 |
| 44 | .01280 | .99992 | .03025 | .99954 | .04769 | .99886 | .06511 | .99788 | .08252 | .99659 | 16 |
| 45 | .01309 | .99991 | .03054 | .99953 | .04798 | .99885 | .06540 | .99786 | .08281 | .99657 | 15 |
| 46 | .01338 | .99991 | .03083 | .99952 | .04827 | .99883 | .06569 | .99784 | .08310 | .99654 | 14 |
| 47 | .01367 | .99991 | .03112 | .99952 | .04856 | .99882 | .06598 | .99782 | .08339 | .99652 | 13 |
| 48 | .01396 | .99990 | .03141 | .99951 | .04885 | .99881 | .06627 | .99780 | .08368 | .99649 | 12 |
| 49 | .01425 | .99990 | .03170 | .99950 | .04914 | .99879 | .06656 | .99778 | .08397 | .99647 | 11 |
| 50 | .01454 | .99989 | .03199 | .99949 | .04943 | .99878 | .06685 | .99776 | .08426 | .99644 | 10 |
| 51 | .01483 | .99989 | .03228 | .99948 | .04972 | .99876 | .06714 | .99774 | .08455 | .99642 | 9 |
| 52 | .01513 | .99989 | .03257 | .99947 | .05001 | .99875 | .06743 | .99772 | .08484 | .99639 | 8 |
| 53 | .01542 | .99988 | .03286 | .99946 | .05030 | .99873 | .06773 | .99770 | .08513 | .99637 | 7 |
| 54 | .01571 | .99988 | .03316 | .99945 | .05059 | .99872 | .06802 | .99768 | .08542 | .99635 | 6 |
| 55 | .01600 | .99987 | .03345 | .99944 | .05088 | .99870 | .06831 | .99766 | .08571 | .99632 | 5 |
| 56 | .01629 | .99987 | .03374 | .99943 | .05117 | .99869 | .06860 | .99764 | .08600 | .99630 | 4 |
| 57 | .01658 | .99986 | .03403 | .99942 | .05146 | .99867 | .06889 | .99762 | .08629 | .99627 | 3 |
| 58 | .01687 | .99986 | .03432 | .99941 | .05175 | .99866 | .06918 | .99760 | .08658 | .99625 | 2 |
| 59 | .01716 | .99985 | .03461 | .99940 | .05205 | .99864 | .06947 | .99758 | .08687 | .99622 | 1 |
| 60 | .01745 | .99985 | .03490 | .99939 | .05234 | .99863 | .06976 | .99756 | .08716 | .99620 | 0 |
| ′ | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | ′ |
| | 89° | | 88° | | 87° | | 86° | | 85° | | |

| ′ | 5° | | 6° | | 7° | | 8° | | 9° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | |
| 0 | .08716 | .99619 | .10453 | .99452 | .12187 | .99255 | .13917 | .99027 | .15643 | .98769 | 60 |
| 1 | .08745 | .99617 | .10482 | .99449 | .12216 | .99251 | .13946 | .99023 | .15672 | .98764 | 59 |
| 2 | .08774 | .99614 | .10511 | .99446 | .12245 | .99248 | .13975 | .99019 | .15701 | .98760 | 58 |
| 3 | .08803 | .99612 | .10540 | .99443 | .12274 | .99244 | .14004 | .99015 | .15730 | .98755 | 57 |
| 4 | .08831 | .99609 | .10569 | .99440 | .12302 | .99240 | .14033 | .99011 | .15758 | .98751 | 56 |
| 5 | .08860 | .99607 | .10597 | .99437 | .12331 | .99237 | .14061 | .99006 | .15787 | .98746 | 55 |
| 6 | .08889 | .99604 | .10626 | .99434 | .12360 | .99233 | .14090 | .99002 | .15816 | .98741 | 54 |
| 7 | .08918 | .99602 | .10655 | .99431 | .12389 | .99230 | .14119 | .98998 | .15845 | .98737 | 53 |
| 8 | .08947 | .99599 | .10684 | .99428 | .12418 | .99226 | .14148 | .98994 | .15873 | .98732 | 52 |
| 9 | .08976 | .99596 | .10713 | .99424 | .12447 | .99222 | .14177 | .98990 | .15902 | .98728 | 51 |
| 10 | .09005 | .99594 | .10742 | .99421 | .12476 | .99219 | .14205 | .98986 | .15931 | .98723 | 50 |
| 11 | .09034 | .99591 | .10771 | .99418 | .12504 | .99215 | .14234 | .98982 | .15959 | .98718 | 49 |
| 12 | .09063 | .99588 | .10800 | .99415 | .12533 | .99211 | .14263 | .98978 | .15988 | .98714 | 48 |
| 13 | .09092 | .99586 | .10829 | .99412 | .12562 | .99208 | .14292 | .98973 | .16017 | .98709 | 47 |
| 14 | .09121 | .99583 | .10858 | .99409 | .12591 | .99204 | .14320 | .98969 | .16046 | .98704 | 46 |
| 15 | .09150 | .99580 | .10887 | .99406 | .12620 | .99200 | .14349 | .98965 | .16074 | .98700 | 45 |
| 16 | .09179 | .99578 | .10916 | .99402 | .12649 | .99197 | .14378 | .98961 | .16103 | .98695 | 44 |
| 17 | .09208 | .99575 | .10945 | .99399 | .12678 | .99193 | .14407 | .98957 | .16132 | .98690 | 43 |
| 18 | .09237 | .99572 | .10973 | .99396 | .12706 | .99189 | .14436 | .98953 | .16160 | .98686 | 42 |
| 19 | .09266 | .99570 | .11002 | .99393 | .12735 | .99186 | .14464 | .98948 | .16189 | .98681 | 41 |
| 20 | .09295 | .99567 | .11031 | .99390 | .12764 | .99182 | .14493 | .98944 | .16218 | .98676 | 40 |
| 21 | .09324 | .99564 | .11060 | .99386 | .12793 | .99178 | .14522 | .98940 | .16246 | .98671 | 39 |
| 22 | .09353 | .99562 | .11089 | .99383 | .12822 | .99175 | .14551 | .98936 | .16275 | .98667 | 38 |
| 23 | .09382 | .99559 | .11118 | .99380 | .12851 | .99171 | .14580 | .98931 | .16304 | .98662 | 37 |
| 24 | .09411 | .99556 | .11147 | .99377 | .12880 | .99167 | .14608 | .98927 | .16333 | .98657 | 36 |
| 25 | .09440 | .99553 | .11176 | .99374 | .12908 | .99163 | .14637 | .98923 | .16361 | .98652 | 35 |
| 26 | .09469 | .99551 | .11205 | .99370 | .12937 | .99160 | .14666 | .98919 | .16390 | .98648 | 34 |
| 27 | .09498 | .99548 | .11234 | .99367 | .12966 | .99156 | .14695 | .98914 | .16419 | .98643 | 33 |
| 28 | .09527 | .99545 | .11263 | .99364 | .12995 | .99152 | .14723 | .98910 | .16447 | .98638 | 32 |
| 29 | .09556 | .99542 | .11291 | .99360 | .13024 | .99148 | .14752 | .98906 | .16476 | .98633 | 31 |
| 30 | .09585 | .99540 | .11320 | .99357 | .13053 | .99144 | .14781 | .98902 | .16505 | .98629 | 30 |
| 31 | .09614 | .99537 | .11349 | .99354 | .13081 | .99141 | .14810 | .98897 | .16533 | .98624 | 29 |
| 32 | .09642 | .99534 | .11378 | .99351 | .13110 | .99137 | .14838 | .98893 | .16562 | .98619 | 28 |
| 33 | .09671 | .99531 | .11407 | .99347 | .13139 | .99133 | .14867 | .98889 | .16591 | .98614 | 27 |
| 34 | .09700 | .99528 | .11436 | .99344 | .13168 | .99129 | .14896 | .98884 | .16620 | .98609 | 26 |
| 35 | .09729 | .99526 | .11465 | .99341 | .13197 | .99125 | .14925 | .98880 | .16648 | .98604 | 25 |
| 36 | .09758 | .99523 | .11494 | .99337 | .13226 | .99122 | .14954 | .98876 | .16677 | .98600 | 24 |
| 37 | .09787 | .99520 | .11523 | .99334 | .13254 | .99118 | .14982 | .98871 | .16706 | .98595 | 23 |
| 38 | .09816 | .99517 | .11552 | .99331 | .13283 | .99114 | .15011 | .98867 | .16734 | .98590 | 22 |
| 39 | .09845 | .99514 | .11580 | .99327 | .13312 | .99110 | .15040 | .98863 | .16763 | .98585 | 21 |
| 40 | .09874 | .99511 | .11609 | .99324 | .13341 | .99106 | .15069 | .98858 | .16792 | .98580 | 20 |
| 41 | .09903 | .99508 | .11638 | .99320 | .13370 | .99102 | .15097 | .98854 | .16820 | .98575 | 19 |
| 42 | .09932 | .99506 | .11667 | .99317 | .13399 | .99098 | .15126 | .98849 | .16849 | .98570 | 18 |
| 43 | .09961 | .99503 | .11696 | .99314 | .13427 | .99094 | .15155 | .98845 | .16878 | .98565 | 17 |
| 44 | .09990 | .99500 | .11725 | .99310 | .13456 | .99091 | .15184 | .98841 | .16906 | .98561 | 16 |
| 45 | .10019 | .99497 | .11754 | .99307 | .13485 | .99087 | .15212 | .98836 | .16935 | .98556 | 15 |
| 46 | .10048 | .99494 | .11783 | .99303 | .13514 | .99083 | .15241 | .98832 | .16964 | .98551 | 14 |
| 47 | .10077 | .99491 | .11812 | .99300 | .13543 | .99079 | .15270 | .98827 | .16992 | .98546 | 13 |
| 48 | .10106 | .99488 | .11840 | .99297 | .13572 | .99075 | .15299 | .98823 | .17021 | .98541 | 12 |
| 49 | .10135 | .99485 | .11869 | .99293 | .13600 | .99071 | .15327 | .98818 | .17050 | .98536 | 11 |
| 50 | .10164 | .99482 | .11898 | .99290 | .13629 | .99067 | .15356 | .98814 | .17078 | .98531 | 10 |
| 51 | .10192 | .99479 | .11927 | .99286 | .13658 | .99063 | .15385 | .98809 | .17107 | .98526 | 9 |
| 52 | .10221 | .99476 | .11956 | .99283 | .13687 | .99059 | .15414 | .98805 | .17136 | .98521 | 8 |
| 53 | .10250 | .99473 | .11985 | .99279 | .13716 | .99055 | .15442 | .98800 | .17164 | .98516 | 7 |
| 54 | .10279 | .99470 | .12014 | .99276 | .13744 | .99051 | .15471 | .98796 | .17193 | .98511 | 6 |
| 55 | .10308 | .99467 | .12043 | .99272 | .13773 | .99047 | .15500 | .98791 | .17222 | .98506 | 5 |
| 56 | .10337 | .99464 | .12071 | .99269 | .13802 | .99043 | .15529 | .98787 | .17250 | .98501 | 4 |
| 57 | .10366 | .99461 | .12100 | .99265 | .13831 | .99039 | .15557 | .98782 | .17279 | .98496 | 3 |
| 58 | .10395 | .99458 | .12129 | .99262 | .13860 | .99035 | .15586 | .98778 | .17308 | .98491 | 2 |
| 59 | .10424 | .99455 | .12158 | .99258 | .13889 | .99031 | .15615 | .98773 | .17336 | .98486 | 1 |
| 60 | .10453 | .99452 | .12187 | .99255 | .13917 | .99027 | .15643 | .98769 | .17365 | .98481 | 0 |
| ′ | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | ′ |
| | 84° | | 83° | | 82° | | 81° | | 80° | | |

| ′ | 10° | | 11° | | 12° | | 13° | | 14° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | |
| 0 | .17365 | .98481 | .19081 | .98163 | .20791 | .97815 | .22495 | .97437 | .24192 | .97030 | 60 |
| 1 | .17393 | .98476 | .19109 | .98157 | .20820 | .97809 | .22523 | .97430 | .24220 | .97023 | 59 |
| 2 | .17422 | .98471 | .19138 | .98152 | .20848 | .97803 | .22552 | .97424 | .24249 | .97015 | 58 |
| 3 | .17451 | .98466 | .19167 | .98146 | .20877 | .97797 | .22580 | .97417 | .24277 | .97008 | 57 |
| 4 | .17479 | .98461 | .19195 | .98140 | .20905 | .97791 | .22608 | .97411 | .24305 | .97001 | 56 |
| 5 | .17508 | .98455 | .19224 | .98135 | .20933 | .97784 | .22637 | .97404 | .24333 | .96994 | 55 |
| 6 | .17537 | .98450 | .19252 | .98129 | .20962 | .97778 | .22665 | .97398 | .24362 | .96987 | 54 |
| 7 | .17565 | .98445 | .19281 | .98124 | .20990 | .97772 | .22693 | .97391 | .24390 | .96980 | 53 |
| 8 | .17594 | .98440 | .19309 | .98118 | .21019 | .97766 | .22722 | .97384 | .24418 | .96973 | 52 |
| 9 | .17623 | .98435 | .19338 | .98112 | .21047 | .97760 | .22750 | .97378 | .24446 | .96966 | 51 |
| 10 | .17651 | .98430 | .19366 | .98107 | .21076 | .97754 | .22778 | .97371 | .24474 | .96959 | 50 |
| 11 | .17680 | .98425 | .19395 | .98101 | .21104 | .97748 | .22807 | .97365 | .24503 | .96952 | 49 |
| 12 | .17708 | .98420 | .19423 | .98096 | .21132 | .97742 | .22835 | .97358 | .24531 | .96945 | 48 |
| 13 | .17737 | .98414 | .19452 | .98090 | .21161 | .97735 | .22863 | .97351 | .24559 | .96937 | 47 |
| 14 | .17766 | .98409 | .19481 | .98084 | .21189 | .97729 | .22892 | .97345 | .24587 | .96930 | 46 |
| 15 | .17794 | .98404 | .19509 | .98079 | .21218 | .97723 | .22920 | .97338 | .24615 | .96923 | 45 |
| 16 | .17823 | .98399 | .19538 | .98073 | .21246 | .97717 | .22948 | .97331 | .24644 | .96916 | 44 |
| 17 | .17852 | .98394 | .19566 | .98067 | .21275 | .97711 | .22977 | .97325 | .24672 | .96909 | 43 |
| 18 | .17880 | .98389 | .19595 | .98061 | .21303 | .97705 | .23005 | .97318 | .24700 | .96902 | 42 |
| 19 | .17909 | .98383 | .19623 | .98056 | .21331 | .97698 | .23033 | .97311 | .24728 | .96894 | 41 |
| 20 | .17937 | .98378 | .19652 | .98050 | .21360 | .97692 | .23062 | .97304 | .24756 | .96887 | 40 |
| 21 | .17966 | .98373 | .19680 | .98044 | .21388 | .97686 | .23090 | .97298 | .24784 | .96880 | 39 |
| 22 | .17995 | .98368 | .19709 | .98039 | .21417 | .97680 | .23118 | .97291 | .24813 | .96873 | 38 |
| 23 | .18023 | .98362 | .19737 | .98033 | .21445 | .97673 | .23146 | .97284 | .24841 | .96866 | 37 |
| 24 | .18052 | .98357 | .19766 | .98027 | .21474 | .97667 | .23175 | .97278 | .24869 | .96858 | 36 |
| 25 | .18081 | .98352 | .19794 | .98021 | .21502 | .97661 | .23203 | .97271 | .24897 | .96851 | 35 |
| 26 | .18109 | .98347 | .19823 | .98016 | .21530 | .97655 | .23231 | .97264 | .24925 | .96844 | 34 |
| 27 | .18138 | .98341 | .19851 | .98010 | .21559 | .97648 | .23260 | .97257 | .24954 | .96837 | 33 |
| 28 | .18166 | .98336 | .19880 | .98004 | .21587 | .97642 | .23288 | .97251 | .24982 | .96829 | 32 |
| 29 | .18195 | .98331 | .19908 | .97998 | .21616 | .97636 | .23316 | .97244 | .25010 | .96822 | 31 |
| 30 | .18224 | .98325 | .19937 | .97992 | .21644 | .97630 | .23345 | .97237 | .25038 | .96815 | 30 |
| 31 | .18252 | .98320 | .19965 | .97987 | .21672 | .97623 | .23373 | .97230 | .25066 | .96807 | 29 |
| 32 | .18281 | .98315 | .19994 | .97981 | .21701 | .97617 | .23401 | .97223 | .25094 | .96800 | 28 |
| 33 | .18309 | .98310 | .20022 | .97975 | .21729 | .97611 | .23429 | .97217 | .25122 | .96793 | 27 |
| 34 | .18338 | .98304 | .20051 | .97969 | .21758 | .97604 | .23458 | .97210 | .25151 | .96786 | 26 |
| 35 | .18367 | .98299 | .20079 | .97963 | .21786 | .97598 | .23486 | .97203 | .25179 | .96778 | 25 |
| 36 | .18395 | .98294 | .20108 | .97958 | .21814 | .97592 | .23514 | .97196 | .25207 | .96771 | 24 |
| 37 | .18424 | .98288 | .20136 | .97952 | .21843 | .97585 | .23542 | .97189 | .25235 | .96764 | 23 |
| 38 | .18452 | .98283 | .20165 | .97946 | .21871 | .97579 | .23571 | .97182 | .25263 | .96756 | 22 |
| 39 | .18481 | .98277 | .20193 | .97940 | .21899 | .97573 | .23599 | .97176 | .25291 | .96749 | 21 |
| 40 | .18509 | .98272 | .20222 | .97934 | .21928 | .97566 | .23627 | .97169 | .25320 | .96742 | 20 |
| 41 | .18538 | .98267 | .20250 | .97928 | .21956 | .97560 | .23656 | .97162 | .25348 | .96734 | 19 |
| 42 | .18567 | .98261 | .20279 | .97922 | .21985 | .97553 | .23684 | .97155 | .25376 | .96727 | 18 |
| 43 | .18595 | .98256 | .20307 | .97916 | .22013 | .97547 | .23712 | .97148 | .25404 | .96719 | 17 |
| 44 | .18624 | .98250 | .20336 | .97910 | .22041 | .97541 | .23740 | .97141 | .25432 | .96712 | 16 |
| 45 | .18652 | .98245 | .20364 | .97905 | .22070 | .97534 | .23769 | .97134 | .25460 | .96705 | 15 |
| 46 | .18681 | .98240 | .20393 | .97899 | .22098 | .97528 | .23797 | .97127 | .25488 | .96697 | 14 |
| 47 | .18710 | .98234 | .20421 | .97893 | .22126 | .97521 | .23825 | .97120 | .25516 | .96690 | 13 |
| 48 | .18738 | .98229 | .20450 | .97887 | .22155 | .97515 | .23853 | .97113 | .25545 | .96682 | 12 |
| 49 | .18767 | .98223 | .20478 | .97881 | .22183 | .97508 | .23882 | .97106 | .25573 | .96675 | 11 |
| 50 | .18795 | .98218 | .20507 | .97875 | .22212 | .97502 | .23910 | .97100 | .25601 | .96667 | 10 |
| 51 | .18824 | .98212 | .20535 | .97869 | .22240 | .97496 | .23938 | .97093 | .25629 | .96660 | 9 |
| 52 | .18852 | .98207 | .20563 | .97863 | .22268 | .97489 | .23966 | .97086 | .25657 | .96653 | 8 |
| 53 | .18881 | .98201 | .20592 | .97857 | .22297 | .97483 | .23995 | .97079 | .25685 | .96645 | 7 |
| 54 | .18910 | .98196 | .20620 | .97851 | .22325 | .97476 | .24023 | .97072 | .25713 | .96638 | 6 |
| 55 | .18938 | .98190 | .20649 | .97845 | .22353 | .97470 | .24051 | .97065 | .25741 | .96630 | 5 |
| 56 | .18967 | .98185 | .20677 | .97839 | .22382 | .97463 | .24079 | .97058 | .25769 | .96623 | 4 |
| 57 | .18995 | .98179 | .20706 | .97833 | .22410 | .97457 | .24108 | .97051 | .25798 | .96615 | 3 |
| 58 | 19024 | .98174 | .20734 | .97827 | .22438 | .97450 | .24136 | .97044 | .25826 | .96608 | 2 |
| 59 | .19052 | .98168 | .20763 | .97821 | .22467 | .97444 | .24164 | .97037 | .25854 | .96600 | 1 |
| 60 | .19081 | .98163 | .20791 | .97815 | .22495 | .97437 | .24192 | .97030 | .25882 | .96593 | 0 |
| ′ | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | ′ |
| | 79° | | 78° | | 77° | | 76° | | 75° | | |

| ′ | 15° | | 16° | | 17° | | 18° | | 19° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | |
| 0 | .25882 | .96593 | .27564 | .96126 | .29237 | .95630 | .30902 | .95106 | .32557 | .94552 | 60 |
| 1 | .25910 | .96585 | .27592 | .96118 | .29265 | .95622 | .30929 | .95097 | .32584 | .94542 | 59 |
| 2 | .25938 | .96578 | .27620 | .96110 | .29293 | .95613 | .30957 | .95088 | .32612 | .94533 | 58 |
| 3 | .25966 | .96570 | .27648 | .96102 | .29321 | .95605 | .30985 | .95079 | .32639 | .94523 | 57 |
| 4 | .25994 | .96562 | .27676 | .96094 | .29348 | .95596 | .31012 | .95070 | .32667 | .94514 | 56 |
| 5 | .26022 | .96555 | .27704 | .96086 | .29376 | .95588 | .31040 | .95061 | .32694 | .94504 | 55 |
| 6 | .26050 | .96547 | .27731 | .96078 | .29404 | .95579 | .31068 | .95052 | .32722 | .94495 | 54 |
| 7 | .26079 | .96540 | .27759 | .96070 | .29432 | .95571 | .31095 | .95043 | .32749 | .94485 | 53 |
| 8 | .26107 | .96532 | .27787 | .96062 | .29460 | .95562 | .31123 | .95033 | .32777 | .94476 | 52 |
| 9 | .26135 | .96524 | .27815 | .96054 | .29487 | .95554 | .31151 | .95024 | .32804 | .94466 | 51 |
| 10 | .26163 | .96517 | .27843 | .96046 | .29515 | .95545 | .31178 | .95015 | .32832 | .94457 | 50 |
| 11 | .26191 | .96509 | .27871 | .96037 | .29543 | .95536 | .31206 | .95006 | .32859 | .94447 | 49 |
| 12 | .26219 | .96502 | .27899 | .96029 | .29571 | .95528 | .31233 | .94997 | .32887 | .94438 | 48 |
| 13 | .26247 | .96494 | .27927 | .96021 | .29599 | .95519 | .31261 | .94988 | .32914 | .94428 | 47 |
| 14 | .26275 | .96486 | .27955 | .96013 | .29626 | .95511 | .31289 | .94979 | .32942 | .94418 | 46 |
| 15 | .26303 | .96479 | .27983 | .96005 | .29654 | .95502 | .31316 | .94970 | .32969 | .94409 | 45 |
| 16 | .26331 | .96471 | .28011 | .95997 | .29682 | .95493 | .31344 | .94961 | .32997 | .94399 | 44 |
| 17 | .26359 | .96463 | .28039 | .95989 | .29710 | .95485 | .31372 | .94952 | .33024 | .94390 | 43 |
| 18 | .26387 | .96456 | .28067 | .95981 | .29737 | .95476 | .31399 | .94943 | .33051 | .94380 | 42 |
| 19 | .26415 | .96448 | .28095 | .95972 | .29765 | .95467 | .31427 | .94933 | .33079 | .94370 | 41 |
| 20 | .26443 | .96440 | .28123 | .95964 | .29793 | .95459 | .31454 | .94924 | .33106 | .94361 | 40 |
| 21 | .26471 | .96433 | .28150 | .95956 | .29821 | .95450 | .31482 | .94915 | .33134 | .94351 | 39 |
| 22 | .26500 | .96425 | .28178 | .95948 | .29849 | .95441 | .31510 | .94906 | .33161 | .94342 | 38 |
| 23 | .26528 | .96417 | .28206 | .95940 | .29876 | .95433 | .31537 | .94897 | .33189 | .94332 | 37 |
| 24 | .26556 | .96410 | .28234 | .95931 | .29904 | .95424 | .31565 | .94888 | .33216 | .94322 | 36 |
| 25 | .26584 | .96402 | .28262 | .95923 | .29932 | .95415 | .31593 | .94878 | .33244 | .94313 | 35 |
| 26 | .26612 | .96394 | .28290 | .95915 | .29960 | .95407 | .31620 | .94869 | .33271 | .94303 | 34 |
| 27 | .26640 | .96386 | .28318 | .95907 | .29987 | .95398 | .31648 | .94860 | .33298 | .94293 | 33 |
| 28 | .26668 | .96379 | .28346 | .95898 | .30015 | .95389 | .31675 | .94851 | .33326 | .94284 | 32 |
| 29 | .26696 | .96371 | .28374 | .95890 | .30043 | .95380 | .31703 | .94842 | .33353 | .94274 | 31 |
| 30 | .26724 | .96363 | .28402 | .95882 | .30071 | .95372 | .31730 | .94832 | .33381 | .94264 | 30 |
| 31 | .26752 | .96355 | .28429 | .95874 | .30098 | .95363 | .31758 | .94823 | .33408 | .94254 | 29 |
| 32 | .26780 | .96347 | .28457 | .95865 | .30126 | .95354 | .31786 | .94814 | .33436 | .94245 | 28 |
| 33 | .26808 | .96340 | .28485 | .95857 | .30154 | .95345 | .31813 | .94805 | .33463 | .94235 | 27 |
| 34 | .26836 | .96332 | .28513 | .95849 | .30182 | .95337 | .31841 | .94795 | .33490 | .94225 | 26 |
| 35 | .26864 | .96324 | .28541 | .95841 | .30209 | .95328 | .31868 | .94786 | .33518 | .94215 | 25 |
| 36 | .26892 | .96316 | .28569 | .95832 | .30237 | .95319 | .31896 | .94777 | .33545 | .94206 | 24 |
| 37 | .26920 | .96308 | .28597 | .95824 | .30265 | .95310 | .31923 | .94768 | .33573 | .94196 | 23 |
| 38 | .26948 | .96301 | .28625 | .95816 | .30292 | .95301 | .31951 | .94758 | .33600 | .94186 | 22 |
| 39 | .26976 | .96293 | .28652 | .95807 | .30320 | .95293 | .31979 | .94749 | .33627 | .94176 | 21 |
| 40 | .27004 | .96285 | .28680 | .95799 | .30348 | .95284 | .32006 | .94740 | .33655 | .94167 | 20 |
| 41 | .27032 | .96277 | .28708 | .95791 | .30376 | .95275 | .32034 | .94730 | .33682 | .94157 | 19 |
| 42 | .27060 | .96269 | .28736 | .95782 | .30403 | .95266 | .32061 | .94721 | .33710 | .94147 | 18 |
| 43 | .27088 | .96261 | .28764 | .95774 | .30431 | .95257 | .32089 | .94712 | .33737 | .94137 | 17 |
| 44 | .27116 | .96253 | .28792 | .95766 | .30459 | .95248 | .32116 | .94702 | .33764 | .94127 | 16 |
| 45 | .27144 | .96246 | .28820 | .95757 | .30486 | .95240 | .32144 | .94693 | .33792 | .94118 | 15 |
| 46 | .27172 | .96238 | .28847 | .95749 | .30514 | .95231 | .32171 | .94684 | .33819 | .94108 | 14 |
| 47 | .27200 | .96230 | .28875 | .95740 | .30542 | .95222 | .32199 | .94674 | .33846 | .94098 | 13 |
| 48 | .27228 | .96222 | .28903 | .95732 | .30570 | .95213 | .32227 | .94665 | .33874 | .94088 | 12 |
| 49 | .27256 | .96214 | .28931 | .95724 | .30597 | .95204 | .32254 | .94656 | .33901 | .94078 | 11 |
| 50 | .27284 | .96206 | .28959 | .95715 | .30625 | .95195 | .32282 | .94646 | .33929 | .94068 | 10 |
| 51 | .27312 | .96198 | .28987 | .95707 | .30653 | .95186 | .32309 | .94637 | .33956 | .94058 | 9 |
| 52 | .27340 | .96190 | .29015 | .95698 | .30680 | .95177 | .32337 | .94627 | .33983 | .94049 | 8 |
| 53 | .27368 | .96182 | .29042 | .95690 | .30708 | .95168 | .32364 | .94618 | .34011 | .94039 | 7 |
| 54 | .27396 | .96174 | .29070 | .95681 | .30736 | .95159 | .32392 | .94609 | .34038 | .94029 | 6 |
| 55 | .27424 | .96166 | .29098 | .95673 | .30763 | .95150 | .32419 | .94599 | .34065 | .94019 | 5 |
| 56 | .27452 | .96158 | .29126 | .95664 | .30791 | .95142 | .32447 | .94590 | .34093 | .94009 | 4 |
| 57 | .27480 | .96150 | .29154 | .95656 | .30819 | .95133 | .32474 | .94580 | .34120 | .93999 | 3 |
| 58 | .27508 | .96142 | .29182 | .95647 | .30846 | .95124 | .32502 | .94571 | .34147 | .93989 | 2 |
| 59 | .27536 | .96134 | .29209 | .95639 | .30874 | .95115 | .32529 | .94561 | .34175 | .93979 | 1 |
| 60 | .27564 | .96126 | .29237 | .95630 | .30902 | .95106 | .32557 | .94552 | .34202 | .93969 | 0 |
| ′ | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | ′ |
| | 74° | | 73° | | 72° | | 71° | | 70° | | |

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

| ′ | 25° | | 26° | | 27° | | 28° | | 29° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | |
| 0 | .42262 | .90631 | .43837 | .89879 | .45399 | .89101 | .46947 | .88295 | .48481 | .87462 | 60 |
| 1 | .42288 | .90618 | .43863 | .89867 | .45425 | .89087 | .46973 | .88281 | .48506 | .87448 | 59 |
| 2 | .42315 | .90606 | .43889 | .89854 | .45451 | .89074 | .46999 | .88267 | .48532 | .87434 | 58 |
| 3 | .42341 | .90594 | .43916 | .89841 | .45477 | .89061 | .47024 | .88254 | .48557 | .87420 | 57 |
| 4 | .42367 | .90582 | .43942 | .89828 | .45503 | .89048 | .47050 | .88240 | .48583 | .87406 | 56 |
| 5 | .42394 | .90569 | .43968 | .89816 | .45529 | .89035 | .47076 | .88226 | .48608 | .87391 | 55 |
| 6 | .42420 | .90557 | .43994 | .89803 | .45554 | .89021 | .47101 | .88213 | .48634 | .87377 | 54 |
| 7 | .42446 | .90545 | .44020 | .89790 | .45580 | .89008 | .47127 | .88199 | .48659 | .87363 | 53 |
| 8 | .42473 | .90532 | .44046 | .89777 | .45606 | .88995 | .47153 | .88185 | .48684 | .87349 | 52 |
| 9 | .42499 | .90520 | .44072 | .89764 | .45632 | .88981 | .47178 | .88172 | .48710 | .87335 | 51 |
| 10 | .42525 | .90507 | .44098 | .89752 | .45658 | .88968 | .47204 | .88158 | .48735 | .87321 | 50 |
| 11 | .42552 | .90495 | .44124 | .89739 | .45684 | .88955 | .47229 | .88144 | .48761 | .87306 | 49 |
| 12 | .42578 | .90483 | .44151 | .89726 | .45710 | .88942 | .47255 | .88130 | .48786 | .87292 | 48 |
| 13 | .42604 | .90470 | .44177 | .89713 | .45736 | .88928 | .47281 | .88117 | .48811 | .87278 | 47 |
| 14 | .42631 | .90458 | .44203 | .89700 | .45762 | .88915 | .47306 | .88103 | .48837 | .87264 | 46 |
| 15 | .42657 | .90446 | .44229 | .89687 | .45787 | .88902 | .47332 | .88089 | .48862 | .87250 | 45 |
| 16 | .42683 | .90433 | .44255 | .89674 | .45813 | .88888 | .47358 | .88075 | .48888 | .87235 | 44 |
| 17 | .42709 | .90421 | .44281 | .89662 | .45839 | .88875 | .47383 | .88062 | .48913 | .87221 | 43 |
| 18 | .42736 | .90408 | .44307 | .89649 | .45865 | .88862 | .47409 | .88048 | .48938 | .87207 | 42 |
| 19 | .42762 | .90396 | .44333 | .89636 | .45891 | .88848 | .47434 | .88034 | .48964 | .87193 | 41 |
| 20 | .42788 | .90383 | .44359 | .89623 | .45917 | .88835 | .47460 | .88020 | .48989 | .87178 | 40 |
| 21 | .42815 | .90371 | .44385 | .89610 | .45942 | .88822 | .47486 | .88006 | .49014 | .87164 | 39 |
| 22 | .42841 | .90358 | .44411 | .89597 | .45968 | .88808 | .47511 | .87993 | .49040 | .87150 | 38 |
| 23 | .42867 | .90346 | .44437 | .89584 | .45994 | .88795 | .47537 | .87979 | .49065 | .87136 | 37 |
| 24 | .42894 | .90334 | .44464 | .89571 | .46020 | .88782 | .47562 | .87965 | .49090 | .87121 | 36 |
| 25 | .42920 | .90321 | .44490 | .89558 | .46046 | .88768 | .47588 | .87951 | .49116 | .87107 | 35 |
| 26 | .42946 | .90309 | .44516 | .89545 | .46072 | .88755 | .47614 | .87937 | .49141 | .87093 | 34 |
| 27 | .42972 | .90296 | .44542 | .89532 | .46097 | .88741 | .47639 | .87923 | .49166 | .87079 | 33 |
| 28 | .42999 | .90284 | .44568 | .89519 | .46123 | .88728 | .47665 | .87909 | .49192 | .87064 | 32 |
| 29 | .43025 | .90271 | .44594 | .89506 | .46149 | .88715 | .47690 | .87896 | .49217 | .87050 | 31 |
| 30 | .43051 | .90259 | .44620 | .89493 | .46175 | .88701 | .47716 | .87882 | .49242 | .87036 | 30 |
| 31 | .43077 | .90246 | .44646 | .89480 | .46201 | .88688 | .47741 | .87868 | .49268 | .87021 | 29 |
| 32 | .43104 | .90233 | .44672 | .89467 | .46226 | .88674 | .47767 | .87854 | .49293 | .87007 | 28 |
| 33 | .43130 | .90221 | .44698 | .89454 | .46252 | .88661 | .47793 | .87840 | .49318 | .86993 | 27 |
| 34 | .43156 | .90208 | .44724 | .89441 | .46278 | .88647 | .47818 | .87826 | .49344 | .86978 | 26 |
| 35 | .43182 | .90196 | .44750 | .89428 | .46304 | .88634 | .47844 | .87812 | .49369 | .86964 | 25 |
| 36 | .43209 | .90183 | .44776 | .89415 | .46330 | .88620 | .47869 | .87798 | .49394 | .86949 | 24 |
| 37 | .43235 | .90171 | .44802 | .89402 | .46355 | .88607 | .47895 | .87784 | .49419 | .86935 | 23 |
| 38 | .43261 | .90158 | .44828 | .89389 | .46381 | .88593 | .47920 | .87770 | .49445 | .86921 | 22 |
| 39 | .43287 | .90146 | .44854 | .89376 | .46407 | .88580 | .47946 | .87756 | .49470 | .86906 | 21 |
| 40 | .43313 | .90133 | .44880 | .89363 | .46433 | .88566 | .47971 | .87743 | .49495 | .86892 | 20 |
| 41 | .43340 | .90120 | .44906 | .89350 | .46458 | .88553 | .47997 | .87729 | .49521 | .86878 | 19 |
| 42 | .43366 | .90108 | .44932 | .89337 | .46484 | .88539 | .48022 | .87715 | .49546 | .86863 | 18 |
| 43 | .43392 | .90095 | .44958 | .89324 | .46510 | .88526 | .48048 | .87701 | .49571 | .86849 | 17 |
| 44 | .43418 | .90082 | .44984 | .89311 | .46536 | .88512 | .48073 | .87687 | .49596 | .86834 | 16 |
| 45 | .43445 | .90070 | .45010 | .89298 | .46561 | .88499 | .48099 | .87673 | .49622 | .86820 | 15 |
| 46 | .43471 | .90057 | .45036 | .89285 | .46587 | .88485 | .48124 | .87659 | .49647 | .86805 | 14 |
| 47 | .43497 | .90045 | .45062 | .89272 | .46613 | .88472 | .48150 | .87645 | .49672 | .86791 | 13 |
| 48 | .43523 | .90032 | .45088 | .89259 | .46639 | .88458 | .48175 | .87631 | .49697 | .86777 | 12 |
| 49 | .43549 | .90019 | .45114 | .89245 | .46664 | .88445 | .48201 | .87617 | .49723 | .86762 | 11 |
| 50 | .43575 | .90007 | .45140 | .89232 | .46690 | .88431 | .48226 | .87603 | .49748 | .86748 | 10 |
| 51 | .43602 | .89994 | .45166 | .89219 | .46716 | .88417 | .48252 | .87589 | .49773 | .86733 | 9 |
| 52 | .43628 | .89981 | .45192 | .89206 | .46742 | .88404 | .48277 | .87575 | .49798 | .86719 | 8 |
| 53 | .43654 | .89968 | .45218 | .89193 | .46767 | .88390 | .48303 | .87561 | .49824 | .86704 | 7 |
| 54 | .43680 | .89956 | .45243 | .89180 | .46793 | .88377 | .48328 | .87546 | .49849 | .86690 | 6 |
| 55 | .43706 | .89943 | .45269 | .89167 | .46819 | .88363 | .48354 | .87532 | .49874 | .86675 | 5 |
| 56 | .43733 | .89930 | .45295 | .89153 | .46844 | .88349 | .48379 | .87518 | .49899 | .86661 | 4 |
| 57 | .43759 | .89918 | .45321 | .89140 | .46870 | .88336 | .48405 | .87504 | .49924 | .86646 | 3 |
| 58 | .43785 | .89905 | .45347 | .89127 | .46896 | .88322 | .48430 | .87490 | .49950 | .86632 | 2 |
| 59 | .43811 | .89892 | .45373 | .89114 | .46921 | .88308 | .48456 | .87476 | .49975 | .86617 | 1 |
| 60 | .43837 | .89879 | .45399 | .89101 | .46947 | .88295 | .48481 | .87462 | .50000 | .86603 | 0 |
| ′ | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | ′ |
| | 64° | | 63° | | 62° | | 61° | | 60° | | |

| ′ | 30° | | 31° | | 32° | | 33° | | 34° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | |
| 0 | .50000 | .86603 | .51504 | .85717 | .52992 | .84805 | .54464 | .83867 | .55919 | .82904 | 60 |
| 1 | .50025 | .86588 | .51529 | .85702 | .53017 | .84789 | .54488 | .83851 | .55943 | .82887 | 59 |
| 2 | .50050 | .86573 | .51554 | .85687 | .53041 | .84774 | .54513 | .83835 | .55968 | .82871 | 58 |
| 3 | .50076 | .86559 | .51579 | .85672 | .53066 | .84759 | .54537 | .83819 | .55992 | .82855 | 57 |
| 4 | .50101 | .86544 | .51604 | .85657 | .53091 | .84743 | .54561 | .83804 | .56016 | .82839 | 56 |
| 5 | .50126 | .86530 | .51628 | .85642 | .53115 | .84728 | .54586 | .83788 | .56040 | .82822 | 55 |
| 6 | .50151 | .86515 | .51653 | .85627 | .53140 | .84712 | .54610 | .83772 | .56064 | .82806 | 54 |
| 7 | .50176 | .86501 | .51678 | .85612 | .53164 | .84697 | .54635 | .83756 | .56088 | .82790 | 53 |
| 8 | .50201 | .86486 | .51703 | .85597 | .53189 | .84681 | .54659 | .83740 | .56112 | .82773 | 52 |
| 9 | .50227 | .86471 | .51728 | .85582 | .53214 | .84666 | .54683 | .83724 | .56136 | .82757 | 51 |
| 10 | .50252 | .86457 | .51753 | .85567 | .53238 | .84650 | .54708 | .83708 | .56160 | .82741 | 50 |
| 11 | .50277 | .86442 | .51778 | .85551 | .53263 | .84635 | .54732 | .83692 | .56184 | .82724 | 49 |
| 12 | .50302 | .86427 | .51803 | .85536 | .53288 | .84619 | .54756 | .83676 | .56208 | .82708 | 48 |
| 13 | .50327 | .86413 | .51828 | .85521 | .53312 | .84604 | .54781 | .83660 | .56232 | .82692 | 47 |
| 14 | .50352 | .86398 | .51852 | .85506 | .53337 | .84588 | .54805 | .83645 | .56256 | .82675 | 46 |
| 15 | .50377 | .86384 | .51877 | .85491 | .53361 | .84573 | .54829 | .83629 | .56280 | .82659 | 45 |
| 16 | .50403 | .86369 | .51902 | .85476 | .53386 | .84557 | .54854 | .83613 | .56305 | .82643 | 44 |
| 17 | .50428 | .86354 | .51927 | .85461 | .53411 | .84542 | .54878 | .83597 | .56329 | .82626 | 43 |
| 18 | .50453 | .86340 | .51952 | .85446 | .53435 | .84526 | .54902 | .83581 | .56353 | .82610 | 42 |
| 19 | .50478 | .86325 | .51977 | .85431 | .53460 | .84511 | .54927 | .83565 | .56377 | .82593 | 41 |
| 20 | .50503 | .86310 | .52002 | .85416 | .53484 | .84495 | .54951 | .83549 | .56401 | .82577 | 40 |
| 21 | .50528 | .86295 | .52026 | .85401 | .53509 | .84480 | .54975 | .83533 | .56425 | .82561 | 39 |
| 22 | .50553 | .86281 | .52051 | .85385 | .53534 | .84464 | .54999 | .83517 | .56449 | .82544 | 38 |
| 23 | .50578 | .86266 | .52076 | .85370 | .53558 | .84448 | .55024 | .83501 | .56473 | .82528 | 37 |
| 24 | .50603 | .86251 | .52101 | .85355 | .53583 | .84433 | .55048 | .83485 | .56497 | .82511 | 36 |
| 25 | .50628 | .86237 | .52126 | .85340 | .53607 | .84417 | .55072 | .83469 | .56521 | .82495 | 35 |
| 26 | .50654 | .86222 | .52151 | .85325 | .53632 | .84402 | .55097 | .83453 | .56545 | .82478 | 34 |
| 27 | .50679 | .86207 | .52175 | .85310 | .53656 | .84386 | .55121 | .83437 | .56569 | .82462 | 33 |
| 28 | .50704 | .86192 | .52200 | .85294 | .53681 | .84370 | .55145 | .83421 | .56593 | .82446 | 32 |
| 29 | .50729 | .86178 | .52225 | .85279 | .53705 | .84355 | .55169 | .83405 | .56617 | .82429 | 31 |
| 30 | .50754 | .86163 | .52250 | .85264 | .53730 | .84339 | .55194 | .83389 | .56641 | .82413 | 30 |
| 31 | .50779 | .86148 | .52275 | .85249 | .53754 | .84324 | .55218 | .83373 | .56665 | .82396 | 29 |
| 32 | .50804 | .86133 | .52299 | .85234 | .53779 | .84308 | .55242 | .83356 | .56689 | .82380 | 28 |
| 33 | .50829 | .86119 | .52324 | .85218 | .53804 | .84292 | .55266 | .83340 | .56713 | .82363 | 27 |
| 34 | .50854 | .86104 | .52349 | .85203 | .53828 | .84277 | .55291 | .83324 | .56736 | .82347 | 26 |
| 35 | .50879 | .86089 | .52374 | .85188 | .53853 | .84261 | .55315 | .83308 | .56760 | .82330 | 25 |
| 36 | .50904 | .86074 | .52399 | .85173 | .53877 | .84245 | .55339 | .83292 | .56784 | .82314 | 24 |
| 37 | .50929 | .86059 | .52423 | .85157 | .53902 | .84230 | .55363 | .83276 | .56808 | .82297 | 23 |
| 38 | .50954 | .86045 | .52448 | .85142 | .53926 | .84214 | .55388 | .83260 | .56832 | .82281 | 22 |
| 39 | .50979 | .86030 | .52473 | .85127 | .53951 | .84198 | .55412 | .83244 | .56856 | .82264 | 21 |
| 40 | .51004 | .86015 | .52498 | .85112 | .53975 | .84182 | .55436 | .83228 | .56880 | .82248 | 20 |
| 41 | .51029 | .86000 | .52522 | .85096 | .54000 | .84167 | .55460 | .83212 | .56904 | .82231 | 19 |
| 42 | .51054 | .85985 | .52547 | .85081 | .54024 | .84151 | .55484 | .83195 | .56928 | .82214 | 18 |
| 43 | .51079 | .85970 | .52572 | .85066 | .54049 | .84135 | .55509 | .83179 | .56952 | .82198 | 17 |
| 44 | .51104 | .85956 | .52597 | .85051 | .54073 | .84120 | .55533 | .83163 | .56976 | .82181 | 16 |
| 45 | .51129 | .85941 | .52621 | .85035 | .54097 | .84104 | .55557 | .83147 | .57000 | .82165 | 15 |
| 46 | .51154 | .85926 | .52646 | .85020 | .54122 | .84088 | .55581 | .83131 | .57024 | .82148 | 14 |
| 47 | .51179 | .85911 | .52671 | .85005 | .54146 | .84072 | .55605 | .83115 | .57047 | .82132 | 13 |
| 48 | .51204 | .85896 | .52696 | .84989 | .54171 | .84057 | .55630 | .83098 | .57071 | .82115 | 12 |
| 49 | .51229 | .85881 | .52720 | .84974 | .54195 | .84041 | .55654 | .83082 | .57095 | .82098 | 11 |
| 50 | .51254 | .85866 | .52745 | .84959 | .54220 | .84025 | .55678 | .83066 | .57119 | .82082 | 10 |
| 51 | .51279 | .85851 | .52770 | .84943 | .54244 | .84009 | .55702 | .83050 | .57143 | .82065 | 9 |
| 52 | .51304 | .85836 | .52794 | .84928 | .54269 | .83994 | .55726 | .83034 | .57167 | .82048 | 8 |
| 53 | .51329 | .85821 | .52819 | .84913 | .54293 | .83978 | .55750 | .83017 | .57191 | .82032 | 7 |
| 54 | .51354 | .85806 | .52844 | .84897 | .54317 | .83962 | .55775 | .83001 | .57215 | .82015 | 6 |
| 55 | .51379 | .85792 | .52869 | .84882 | .54342 | .83946 | .55799 | .82985 | .57238 | .81999 | 5 |
| 56 | .51404 | .85777 | .52893 | .84866 | .54366 | .83930 | .55823 | .82969 | .57262 | .81982 | 4 |
| 57 | .51429 | .85762 | .52918 | .84851 | .54391 | .83915 | .55847 | .82953 | .57286 | .81965 | 3 |
| 58 | .51454 | .85747 | .52943 | .84836 | .54415 | .83899 | .55871 | .82936 | .57310 | .81949 | 2 |
| 59 | .51479 | .85732 | .52967 | .84820 | .54440 | .83883 | .55895 | .82920 | .57334 | .81932 | 1 |
| 60 | .51504 | .85717 | .52992 | .84805 | .54464 | .83867 | .55919 | .82904 | .57358 | .81915 | 0 |
| ′ | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | ′ |
| | 59° | | 58° | | 57° | | 56° | | 55° | | |

| ′ | 35° | | 36° | | 37° | | 38° | | 39° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | |
| 0 | .57358 | .81915 | .58779 | .80902 | .60182 | .79864 | .61566 | .78801 | .62932 | .77715 | 60 |
| 1 | .57381 | .81899 | .58802 | .80885 | .60205 | .79846 | .61589 | .78783 | .62955 | .77696 | 59 |
| 2 | .57405 | .81882 | .58826 | .80867 | .60228 | .79829 | .61612 | .78765 | .62977 | .77678 | 58 |
| 3 | .57429 | .81865 | .58849 | .80850 | .60251 | .79811 | .61635 | .78747 | .63000 | .77660 | 57 |
| 4 | .57453 | .81848 | .58873 | .80833 | .60274 | .79793 | .61658 | .78729 | .63022 | .77641 | 56 |
| 5 | .57477 | .81832 | .58896 | .80816 | .60298 | .79776 | .61681 | .78711 | .63045 | .77623 | 55 |
| 6 | .57501 | .81815 | .58920 | .80799 | .60321 | .79758 | .61704 | .78694 | .63068 | .77605 | 54 |
| 7 | .57524 | .81798 | .58943 | .80782 | .60344 | .79741 | .61726 | .78676 | .63090 | .77586 | 53 |
| 8 | .57548 | .81782 | .58967 | .80765 | .60367 | .79723 | .61749 | .78658 | .63113 | .77568 | 52 |
| 9 | .57572 | .81765 | .58990 | .80748 | .60390 | .79706 | .61772 | .78640 | .63135 | .77550 | 51 |
| 10 | .57596 | .81748 | .59014 | .80730 | .60414 | .79688 | .61795 | .78622 | .63158 | .77531 | 50 |
| 11 | .57619 | .81731 | .59037 | .80713 | .60437 | .79671 | .61818 | .78604 | .63180 | .77513 | 49 |
| 12 | .57643 | .81714 | .59061 | .80696 | .60460 | .79653 | .61841 | .78586 | .63203 | .77494 | 48 |
| 13 | .57667 | .81698 | .59084 | .80679 | .60483 | .79635 | .61864 | .78568 | .63225 | .77476 | 47 |
| 14 | .57691 | .81681 | .59108 | .80662 | .60506 | .79618 | .61887 | .78550 | .63248 | .77458 | 46 |
| 15 | .57715 | .81664 | .59131 | .80644 | .60529 | .79600 | .61909 | .78532 | .63271 | .77439 | 45 |
| 16 | .57738 | .81647 | .59154 | .80627 | .60553 | .79583 | .61932 | .78514 | .63293 | .77421 | 44 |
| 17 | .57762 | .81631 | .59178 | .80610 | .60576 | .79565 | .61955 | .78496 | .63316 | .77402 | 43 |
| 18 | .57786 | .81614 | .59201 | .80593 | .60599 | .79547 | .61978 | .78478 | .63338 | .77384 | 42 |
| 19 | .57810 | .81597 | .59225 | .80576 | .60622 | .79530 | .62001 | .78460 | .63361 | .77366 | 41 |
| 20 | .57833 | .81580 | .59248 | .80558 | .60645 | .79512 | .62024 | .78442 | .63383 | .77347 | 40 |
| 21 | .57857 | .81563 | .59272 | .80541 | .60668 | .79494 | .62046 | .78424 | .63406 | .77329 | 39 |
| 22 | .57881 | .81546 | .59295 | .80524 | .60691 | .79477 | .62069 | .78405 | .63428 | .77310 | 38 |
| 23 | .57904 | .81530 | .59318 | .80507 | .60714 | .79459 | .62092 | .78387 | .63451 | .77292 | 37 |
| 24 | .57928 | .81513 | .59342 | .80489 | .60738 | .79441 | .62115 | .78369 | .63473 | .77273 | 36 |
| 25 | .57952 | .81496 | .59365 | .80472 | .60761 | .79424 | .62138 | .78351 | .63496 | .77255 | 35 |
| 26 | .57976 | .81479 | .59389 | .80455 | .60784 | .79406 | .62160 | .78333 | .63518 | .77236 | 34 |
| 27 | .57999 | .81462 | .59412 | .80438 | .60807 | .79388 | .62183 | .78315 | .63540 | .77218 | 33 |
| 28 | .58023 | .81445 | .59436 | .80420 | .60830 | .79371 | .62206 | .78297 | .63563 | .77199 | 32 |
| 29 | .58047 | .81428 | .59459 | .80403 | .60853 | .79353 | .62229 | .78279 | .63585 | .77181 | 31 |
| 30 | .58070 | .81412 | .59482 | .80386 | .60876 | .79335 | .62251 | .78261 | .63608 | .77162 | 30 |
| 31 | .58094 | .81395 | .59506 | .80368 | .60899 | .79318 | .62274 | .78243 | .63630 | .77144 | 29 |
| 32 | .58118 | .81378 | .59529 | .80351 | .60922 | .79300 | .62297 | .78225 | .63653 | .77125 | 28 |
| 33 | .58141 | .81361 | .59552 | .80334 | .60945 | .79282 | .62320 | .78206 | .63675 | .77107 | 27 |
| 34 | .58165 | .81344 | .59576 | .80316 | .60968 | .79264 | .62342 | .78188 | .63698 | .77088 | 26 |
| 35 | .58189 | .81327 | .59599 | .80299 | .60991 | .79247 | .62365 | .78170 | .63720 | .77070 | 25 |
| 36 | .58212 | .81310 | .59622 | .80282 | .61015 | .79229 | .62388 | .78152 | .63742 | .77051 | 24 |
| 37 | .58236 | .81293 | .59646 | .80264 | .61038 | .79211 | .62411 | .78134 | .63765 | .77033 | 23 |
| 38 | .58260 | .81276 | .59669 | .80247 | .61061 | .79193 | .62433 | .78116 | .63787 | .77014 | 22 |
| 39 | .58283 | .81259 | .59693 | .80230 | .61084 | .79176 | .62456 | .78098 | .63810 | .76996 | 21 |
| 40 | .58307 | .81242 | .59716 | .80212 | .61107 | .79158 | .62479 | .78079 | .63832 | .76977 | 20 |
| 41 | .58330 | .81225 | .59739 | .80195 | .61130 | .79140 | .62502 | .78061 | .63854 | .76959 | 19 |
| 42 | .58354 | .81208 | .59763 | .80178 | .61153 | .79122 | .62524 | .78043 | .63877 | .76940 | 18 |
| 43 | .58378 | .81191 | .59786 | .80160 | .61176 | .79105 | .62547 | .78025 | .63899 | .76921 | 17 |
| 44 | .58401 | .81174 | .59809 | .80143 | .61199 | .79087 | .62570 | .78007 | .63922 | .76903 | 16 |
| 45 | .58425 | .81157 | .59832 | .80125 | .61222 | .79069 | .62592 | .77988 | .63944 | .76884 | 15 |
| 46 | .58449 | .81140 | .59856 | .80108 | .61245 | .79051 | .62615 | .77970 | .63966 | .76866 | 14 |
| 47 | .58472 | .81123 | .59879 | .80091 | .61268 | .79033 | .62638 | .77952 | .63989 | .76847 | 13 |
| 48 | .58496 | .81106 | .59902 | .80073 | .61291 | .79016 | .62660 | .77934 | .64011 | .76828 | 12 |
| 49 | .58519 | .81089 | .59926 | .80056 | .61314 | .78998 | .62683 | .77916 | .64033 | .76810 | 11 |
| 50 | .58543 | .81072 | .59949 | .80038 | .61337 | .78980 | .62706 | .77897 | .64056 | .76791 | 10 |
| 51 | .58567 | .81055 | .59972 | .80021 | .61360 | .78962 | .62728 | .77879 | .64078 | .76772 | 9 |
| 52 | .58590 | .81038 | .59995 | .80003 | .61383 | .78944 | .62751 | .77861 | .64100 | .76754 | 8 |
| 53 | .58614 | .81021 | .60019 | .79986 | .61406 | .78926 | .62774 | .77843 | .64123 | .76735 | 7 |
| 54 | .58637 | .81004 | .60042 | .79968 | .61429 | .78908 | .62796 | .77824 | .64145 | .76717 | 6 |
| 55 | .58661 | .80987 | .60065 | .79951 | .61451 | .78891 | .62819 | .77806 | .64167 | .76698 | 5 |
| 56 | .58684 | .80970 | .60089 | .79934 | .61474 | .78873 | .62842 | .77788 | .64190 | .76679 | 4 |
| 57 | .58708 | .80953 | .60112 | .79916 | .61497 | .78855 | .62864 | .77769 | .64212 | .76661 | 3 |
| 58 | .58731 | .80936 | .60135 | .79899 | .61520 | .78837 | .62887 | .77751 | .64234 | .76642 | 2 |
| 59 | .58755 | .80919 | .60158 | .79881 | .61543 | .78819 | .62909 | .77733 | .64256 | .76623 | 1 |
| 60 | .58779 | .80902 | .60182 | .79864 | .61566 | .78801 | .62932 | .77715 | .64279 | .76604 | 0 |
| ′ | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | ′ |
| | 54° | | 53° | | 52° | | 51° | | 50° | | |

| ′ | 40° | | 41° | | 42° | | 43° | | 44° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | |
| 0 | .64279 | .76604 | .65606 | .75471 | .66913 | .74314 | .68200 | .73135 | .69466 | .71934 | 60 |
| 1 | .64301 | .76586 | .65628 | .75452 | .66935 | .74295 | .68221 | .73116 | .69487 | .71914 | 59 |
| 2 | .64323 | .76567 | .65650 | .75433 | .66956 | .74276 | .68242 | .73096 | .69508 | .71894 | 58 |
| 3 | .64346 | .76548 | .65672 | .75414 | .66978 | .74256 | .68264 | .73076 | .69529 | .71873 | 57 |
| 4 | .64368 | .76530 | .65694 | .75395 | .66999 | .74237 | .68285 | .73056 | .69549 | .71853 | 56 |
| 5 | .64390 | .76511 | .65716 | .75375 | .67021 | .74217 | .68306 | .73036 | .69570 | .71833 | 55 |
| 6 | .64412 | .76492 | .65738 | .75356 | .67043 | .74198 | .68327 | .73016 | .69591 | .71813 | 54 |
| 7 | .64435 | .76473 | .65759 | .75337 | .67064 | .74178 | .68349 | .72996 | .69612 | .71792 | 53 |
| 8 | .64457 | .76455 | .65781 | .75318 | .67086 | .74159 | .68370 | .72976 | .69633 | .71772 | 52 |
| 9 | .64479 | .76436 | .65803 | .75299 | .67107 | .74139 | .68391 | .72957 | .69654 | .71752 | 51 |
| 10 | .64501 | .76417 | .65825 | .75280 | .67129 | .74120 | .68412 | .72937 | .69675 | .71732 | 50 |
| 11 | .64524 | .76398 | .65847 | .75261 | .67151 | .74100 | .68434 | .72917 | .69696 | .71711 | 49 |
| 12 | .64546 | .76380 | .65869 | .75241 | .67172 | .74080 | .68455 | .72897 | .69717 | .71691 | 48 |
| 13 | .64568 | .76361 | .65891 | .75222 | .67194 | .74061 | .68476 | .72877 | .69737 | .71671 | 47 |
| 14 | .64590 | .76342 | .65913 | .75203 | .67215 | .74041 | .68497 | .72857 | .69758 | .71650 | 46 |
| 15 | .64612 | .76323 | .65935 | .75184 | .67237 | .74022 | .68518 | .72837 | .69779 | .71630 | 45 |
| 16 | .64635 | .76304 | .65956 | .75165 | .67258 | .74002 | .68539 | .72817 | .69800 | .71610 | 44 |
| 17 | .64657 | .76286 | .65978 | .75146 | .67280 | .73983 | .68561 | .72797 | .69821 | .71590 | 43 |
| 18 | .64679 | .76267 | .66000 | .75126 | .67301 | .73963 | .68582 | .72777 | .69842 | .71569 | 42 |
| 19 | .64701 | .76248 | .66022 | .75107 | .67323 | .73944 | .68603 | .72757 | .69862 | .71549 | 41 |
| 20 | .64723 | .76229 | .66044 | .75088 | .67344 | .73924 | .68624 | .72737 | .69883 | .71529 | 40 |
| 21 | .64746 | .76210 | .66066 | .75069 | .67366 | .73904 | .68645 | .72717 | .69904 | .71508 | 39 |
| 22 | .64768 | .76192 | .66088 | .75050 | .67387 | .73885 | .68666 | .72697 | .69925 | .71488 | 38 |
| 23 | .64790 | .76173 | .66109 | .75030 | .67409 | .73865 | .68688 | .72677 | .69946 | .71468 | 37 |
| 24 | .64812 | .76154 | .66131 | .75011 | .67430 | .73846 | .68709 | .72657 | .69966 | .71447 | 36 |
| 25 | .64834 | .76135 | .66153 | .74992 | .67452 | .73826 | .68730 | .72637 | .69987 | .71427 | 35 |
| 26 | .64856 | .76116 | .66175 | .74973 | .67473 | .73806 | .68751 | .72617 | .70008 | .71407 | 34 |
| 27 | .64878 | .76097 | .66197 | .74953 | .67495 | .73787 | .68772 | .72597 | .70029 | .71386 | 33 |
| 28 | .64901 | .76078 | .66218 | .74934 | .67516 | .73767 | .68793 | .72577 | .70049 | .71366 | 32 |
| 29 | .64923 | .76059 | .66240 | .74915 | .67538 | .73747 | .68814 | .72557 | .70070 | .71345 | 31 |
| 30 | .64945 | .76041 | .66262 | .74896 | .67559 | .73728 | .68835 | .72537 | .70091 | .71325 | 30 |
| 31 | .64967 | .76022 | .66284 | .74876 | .67580 | .73708 | .68857 | .72517 | .70112 | .71305 | 29 |
| 32 | .64989 | .76003 | .66306 | .74857 | .67602 | .73688 | .68878 | .72497 | .70132 | .71284 | 28 |
| 33 | .65011 | .75984 | .66327 | .74838 | .67623 | .73669 | .68899 | .72477 | .70153 | .71264 | 27 |
| 34 | .65033 | .75965 | .66349 | .74818 | .67645 | .73649 | .68920 | .72457 | .70174 | .71243 | 26 |
| 35 | .65055 | .75946 | .66371 | .74799 | .67666 | .73629 | .68941 | .72437 | .70195 | .71223 | 25 |
| 36 | .65077 | .75927 | .66393 | .74780 | .67688 | .73610 | .68962 | .72417 | .70215 | .71203 | 24 |
| 37 | .65100 | .75908 | .66414 | .74760 | .67709 | .73590 | .68983 | .72397 | .70236 | .71182 | 23 |
| 38 | .65122 | .75889 | .66436 | .74741 | .67730 | .73570 | .69004 | .72377 | .70257 | .71162 | 22 |
| 39 | .65144 | .75870 | .66458 | .74722 | .67752 | .73551 | .69025 | .72357 | .70277 | .71141 | 21 |
| 40 | .65166 | .75851 | .66480 | .74703 | .67773 | .73531 | .69046 | .72337 | .70298 | .71121 | 20 |
| 41 | .65188 | .75832 | .66501 | .74683 | .67795 | .73511 | .69067 | .72317 | .70319 | .71100 | 19 |
| 42 | .65210 | .75813 | .66523 | .74664 | .67816 | .73491 | .69088 | .72297 | .70339 | .71080 | 18 |
| 43 | .65232 | .75794 | .66545 | .74644 | .67837 | .73472 | .69109 | .72277 | .70360 | .71059 | 17 |
| 44 | .65254 | .75775 | .66566 | .74625 | .67859 | .73452 | .69130 | .72257 | .70381 | .71039 | 16 |
| 45 | .65276 | .75756 | .66588 | .74606 | .67880 | .73432 | .69151 | .72236 | .70401 | .71019 | 15 |
| 46 | .65298 | .75738 | .66610 | .74586 | .67901 | .73413 | .69172 | .72216 | .70422 | .70998 | 14 |
| 47 | .65320 | .75719 | .66632 | .74567 | .67923 | .73393 | .69193 | .72196 | .70443 | .70978 | 13 |
| 48 | .65342 | .75700 | .66653 | .74548 | .67944 | .73373 | .69214 | .72176 | .70463 | .70957 | 12 |
| 49 | .65364 | .75680 | .66675 | .74528 | .67965 | .73353 | .69235 | .72156 | .70484 | .70937 | 11 |
| 50 | .65386 | .75661 | .66697 | .74509 | .67987 | .73333 | .69256 | .72136 | .70505 | .70916 | 10 |
| 51 | .65408 | .75642 | .66718 | .74489 | .68008 | .73314 | .69277 | .72116 | .70525 | .70896 | 9 |
| 52 | .65430 | .75623 | .66740 | .74470 | .68029 | .73294 | .69298 | .72095 | .70546 | .70875 | 8 |
| 53 | .65452 | .75604 | .66762 | .74451 | .68051 | .73274 | .69319 | .72075 | .70567 | .70855 | 7 |
| 54 | .65474 | .75585 | .66783 | .74431 | .68072 | .73254 | .69340 | .72055 | .70587 | .70834 | 6 |
| 55 | .65496 | .75566 | .66805 | .74412 | .68093 | .73234 | .69361 | .72035 | .70608 | .70813 | 5 |
| 56 | .65518 | .75547 | .66827 | .74392 | .68115 | .73215 | .69382 | .72015 | .70628 | .70793 | 4 |
| 57 | .65540 | .75528 | .66848 | .74373 | .68136 | .73195 | .69403 | .71995 | .70649 | .70772 | 3 |
| 58 | .65562 | .75509 | .66870 | .74353 | .68157 | .73175 | .69424 | .71974 | .70670 | .70752 | 2 |
| 59 | .65584 | .75490 | .66891 | .74334 | .68179 | .73155 | .69445 | .71954 | .70690 | .70731 | 1 |
| 60 | .65606 | .75471 | .66913 | .74314 | .68200 | .73135 | .69466 | .71934 | .70711 | .70711 | 0 |
| ′ | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | Cosine | Sine | ′ |
| | 49° | | 48° | | 47° | | 46° | | 45° | | |

| ′ | 0° | | 1° | | 2° | | 3° | | 4° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | |
| 0 | .00000 | Infin. | .01746 | 57.2900 | .03492 | 28.6363 | .05241 | 19.0811 | .06993 | 14.3007 | 60 |
| 1 | .00029 | 3437.75 | .01775 | 56.3506 | .03521 | 28.3994 | .05270 | 18.9755 | .07022 | 14.2411 | 59 |
| 2 | .00058 | 1718.87 | .01804 | 55.4415 | .03550 | 28.1664 | .05299 | 18.8711 | .07051 | 14.1821 | 58 |
| 3 | .00087 | 1145.92 | .01833 | 54.5613 | .03579 | 27.9372 | .05328 | 18.7678 | .07080 | 14.1235 | 57 |
| 4 | .00116 | 859.436 | .01862 | 53.7086 | .03609 | 27.7117 | .05357 | 18.6656 | .07110 | 14.0655 | 56 |
| 5 | .00145 | 687.549 | .01891 | 52.8821 | .03638 | 27.4899 | .05387 | 18.5645 | .07139 | 14.0079 | 55 |
| 6 | .00175 | 572.957 | .01920 | 52.0807 | .03667 | 27.2715 | .05416 | 18.4645 | .07168 | 13.9507 | 54 |
| 7 | .00204 | 491.106 | .01949 | 51.3032 | .03696 | 27.0566 | .05445 | 18.3655 | .07197 | 13.8940 | 53 |
| 8 | .00233 | 429.718 | .01978 | 50.5485 | .03725 | 26.8450 | .05474 | 18.2677 | .07227 | 13.8378 | 52 |
| 9 | .00262 | 381.971 | .02007 | 49.8157 | .03754 | 26.6367 | .05503 | 18.1708 | .07256 | 13.7821 | 51 |
| 10 | .00291 | 343.774 | .02036 | 49.1039 | .03783 | 26.4316 | .05533 | 18.0750 | .07285 | 13.7267 | 50 |
| 11 | .00320 | 312.521 | .02066 | 48.4121 | .03812 | 26.2296 | .05562 | 17.9802 | .07314 | 13.6719 | 49 |
| 12 | .00349 | 286.478 | .02095 | 47.7395 | .03842 | 26.0307 | .05591 | 17.8863 | .07344 | 13.6174 | 48 |
| 13 | .00378 | 264.441 | .02124 | 47.0853 | .03871 | 25.8348 | .05620 | 17.7934 | .07373 | 13.5634 | 47 |
| 14 | .00407 | 245.552 | .02153 | 46.4489 | .03900 | 25.6418 | .05649 | 17.7015 | .07402 | 13.5098 | 46 |
| 15 | .00436 | 229.182 | .02182 | 45.8294 | .03929 | 25.4517 | .05678 | 17.6106 | .07431 | 13.4566 | 45 |
| 16 | .00465 | 214.858 | .02211 | 45.2261 | .03958 | 25.2644 | .05708 | 17.5205 | .07461 | 13.4039 | 44 |
| 17 | .00495 | 202.219 | .02240 | 44.6386 | .03987 | 25.0798 | .05737 | 17.4314 | .07490 | 13.3515 | 43 |
| 18 | .00524 | 190.984 | .02269 | 44.0661 | .04016 | 24.8978 | .05766 | 17.3432 | .07519 | 13.2996 | 42 |
| 19 | .00553 | 180.932 | .02298 | 43.5081 | .04046 | 24.7185 | .05795 | 17.2558 | .07548 | 13.2480 | 41 |
| 20 | .00582 | 171.885 | .02328 | 42.9641 | .04075 | 24.5418 | .05824 | 17.1693 | .07578 | 13.1969 | 40 |
| 21 | .00611 | 163.700 | .02357 | 42.4335 | .04104 | 24.3675 | .05854 | 17.0837 | .07607 | 13.1461 | 39 |
| 22 | .00640 | 156.259 | .02386 | 41.9158 | .04133 | 24.1957 | .05883 | 16.9990 | .07636 | 13.0958 | 38 |
| 23 | .00669 | 149.465 | .02415 | 41.4106 | .04162 | 24.0263 | .05912 | 16.9150 | .07665 | 13.0458 | 37 |
| 24 | .00698 | 143.237 | .02444 | 40.9174 | .04191 | 23.8593 | .05941 | 16.8319 | .07695 | 12.9962 | 36 |
| 25 | .00727 | 137.507 | .02473 | 40.4358 | .04220 | 23.6945 | .05970 | 16.7496 | .07724 | 12.9469 | 35 |
| 26 | .00756 | 132.219 | .02502 | 39.9655 | .04250 | 23.5321 | .05999 | 16.6681 | .07753 | 12.8981 | 34 |
| 27 | .00785 | 127.321 | .02531 | 39.5059 | .04279 | 23.3718 | .06029 | 16.5874 | .07782 | 12.8496 | 33 |
| 28 | .00815 | 122.774 | .02560 | 39.0568 | .04308 | 23.2137 | .06058 | 16.5075 | .07812 | 12.8014 | 32 |
| 29 | .00844 | 118.540 | .02589 | 38.6177 | .04337 | 23.0577 | .06087 | 16.4283 | .07841 | 12.7536 | 31 |
| 30 | .00873 | 114.589 | .02619 | 38.1885 | .04366 | 22.9038 | .06116 | 16.3499 | .07870 | 12.7062 | 30 |
| 31 | .00902 | 110.892 | .02648 | 37.7686 | .04395 | 22.7519 | .06145 | 16.2722 | .07899 | 12.6591 | 29 |
| 32 | .00931 | 107.426 | .02677 | 37.3579 | .04424 | 22.6020 | .06175 | 16.1952 | .07929 | 12.6124 | 28 |
| 33 | .00960 | 104.171 | .02706 | 36.9560 | .04454 | 22.4541 | .06204 | 16.1190 | .07958 | 12.5660 | 27 |
| 34 | .00989 | 101.107 | .02735 | 36.5627 | .04483 | 22.3081 | .06233 | 16.0435 | .07987 | 12.5199 | 26 |
| 35 | .01018 | 98.2179 | .02764 | 36.1776 | .04512 | 22.1640 | .06262 | 15.9687 | .08017 | 12.4742 | 25 |
| 36 | .01047 | 95.4895 | .02793 | 35.8006 | .04541 | 22.0217 | .06291 | 15.8945 | .08046 | 12.4288 | 24 |
| 37 | .01076 | 92.9085 | .02822 | 35.4313 | .04570 | 21.8813 | .06321 | 15.8211 | .08075 | 12.3838 | 23 |
| 38 | .01105 | 90.4633 | .02851 | 35.0695 | .04599 | 21.7426 | .06350 | 15.7483 | .08104 | 12.3390 | 22 |
| 39 | .01135 | 88.1436 | .02881 | 34.7151 | .04628 | 21.6056 | .06379 | 15.6762 | .08134 | 12.2946 | 21 |
| 40 | .01164 | 85.9398 | .02910 | 34.3678 | .04658 | 21.4704 | .06408 | 15.6048 | .08163 | 12.2505 | 20 |
| 41 | .01193 | 83.8435 | .02939 | 34.0273 | .04687 | 21.3369 | .06437 | 15.5340 | .08192 | 12.2067 | 19 |
| 42 | .01222 | 81.8470 | .02968 | 33.6935 | .04716 | 21.2049 | .06467 | 15.4638 | .08221 | 12.1632 | 18 |
| 43 | .01251 | 79.9434 | .02997 | 33.3662 | .04745 | 21.0747 | .06496 | 15.3943 | .08251 | 12.1201 | 17 |
| 44 | .01280 | 78.1263 | .03026 | 33.0452 | .04774 | 20.9460 | .06525 | 15.3254 | .08280 | 12.0772 | 16 |
| 45 | .01309 | 76.3900 | .03055 | 32.7303 | .04803 | 20.8188 | .06554 | 15.2571 | .08309 | 12.0346 | 15 |
| 46 | .01338 | 74.7292 | .03084 | 32.4213 | .04833 | 20.6932 | .06584 | 15.1893 | .08339 | 11.9923 | 14 |
| 47 | .01367 | 73.1390 | .03114 | 32.1181 | .04862 | 20.5691 | .06613 | 15.1222 | .08368 | 11.9504 | 13 |
| 48 | .01396 | 71.6151 | .03143 | 31.8205 | .04891 | 20.4465 | .06642 | 15.0557 | .08397 | 11.9087 | 12 |
| 49 | .01425 | 70.1533 | .03172 | 31.5284 | .04920 | 20.3253 | .06671 | 14.9898 | .08427 | 11.8673 | 11 |
| 50 | .01455 | 68.7501 | .03201 | 31.2416 | .04949 | 20.2056 | .06700 | 14.9244 | .08456 | 11.8262 | 10 |
| 51 | .01484 | 67.4019 | .03230 | 30.9599 | .04978 | 20.0872 | .06730 | 14.8596 | .08485 | 11.7853 | 9 |
| 52 | .01513 | 66.1055 | .03259 | 30.6833 | .05007 | 19.9702 | .06759 | 14.7954 | .08514 | 11.7448 | 8 |
| 53 | .01542 | 64.8580 | .03288 | 30.4116 | .05037 | 19.8546 | .06788 | 14.7317 | .08544 | 11.7045 | 7 |
| 54 | .01571 | 63.6567 | .03317 | 30.1446 | .05066 | 19.7403 | .06817 | 14.6685 | .08573 | 11.6645 | 6 |
| 55 | .01600 | 62.4992 | .03346 | 29.8823 | .05095 | 19.6273 | .06847 | 14.6059 | .08602 | 11.6248 | 5 |
| 56 | .01629 | 61.3829 | .03376 | 29.6245 | .05124 | 19.5156 | .06876 | 14.5438 | .08632 | 11.5853 | 4 |
| 57 | .01658 | 60.3058 | .03405 | 29.3711 | .05153 | 19.4051 | .06905 | 14.4823 | .08661 | 11.5461 | 3 |
| 58 | .01687 | 59.2659 | .03434 | 29.1220 | .05182 | 19.2959 | .06934 | 14.4212 | .08690 | 11.5072 | 2 |
| 59 | .01716 | 58.2612 | .03463 | 28.8771 | .05212 | 19.1879 | .06963 | 14.3607 | .08720 | 11.4685 | 1 |
| 60 | .01746 | 57.2900 | .03492 | 28.6363 | .05241 | 19.0811 | .06993 | 14.3007 | .08749 | 11.4301 | 0 |
| ′ | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | ′ |
| | 89° | | 88° | | 87° | | 86° | | 85° | | |

| ′ | 5° | | 6° | | 7° | | 8° | | 9° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | |
| 0 | .08749 | 11.4301 | .10510 | 9.51436 | .12278 | 8.14435 | .14054 | 7.11537 | .15838 | 6.31375 | 60 |
| 1 | .08778 | 11.3919 | .10540 | 9.48781 | .12308 | 8.12481 | .14084 | 7.10038 | .15868 | 6.30189 | 59 |
| 2 | .08807 | 11.3540 | .10569 | 9.46141 | .12338 | 8.10536 | .14113 | 7.08546 | .15898 | 6.29007 | 58 |
| 3 | .08837 | 11.3163 | .10599 | 9.43515 | .12367 | 8.08600 | .14143 | 7.07059 | .15928 | 6.27829 | 57 |
| 4 | .08866 | 11.2789 | .10628 | 9.40904 | .12397 | 8.06674 | .14173 | 7.05579 | .15958 | 6.26655 | 56 |
| 5 | .08895 | 11.2417 | .10657 | 9.38307 | .12426 | 8.04756 | .14202 | 7.04105 | .15988 | 6.25486 | 55 |
| 6 | .08925 | 11.2048 | .10687 | 9.35724 | .12456 | 8.02848 | .14232 | 7.02637 | .16017 | 6.24321 | 54 |
| 7 | .08954 | 11.1681 | .10716 | 9.33155 | .12485 | 8.00948 | .14262 | 7.01174 | .16047 | 6.23160 | 53 |
| 8 | .08983 | 11.1316 | .10746 | 9.30599 | .12515 | 7.99058 | .14291 | 6.99718 | .16077 | 6.22003 | 52 |
| 9 | .09013 | 11.0954 | .10775 | 9.28056 | .12544 | 7.97176 | .14321 | 6.98268 | .16107 | 6.20851 | 51 |
| 10 | .09042 | 11.0594 | .10805 | 9.25530 | .12574 | 7.95302 | .14351 | 6.96823 | .16137 | 6.19703 | 50 |
| 11 | .09071 | 11.0237 | .10834 | 9.23016 | .12603 | 7.93438 | .14381 | 6.95385 | .16167 | 6.18559 | 49 |
| 12 | .09101 | 10.9882 | .10863 | 9.20516 | .12633 | 7.91582 | .14410 | 6.93952 | .16196 | 6.17419 | 48 |
| 13 | .09130 | 10.9529 | .10893 | 9.18028 | .12662 | 7.89734 | .14440 | 6.92525 | .16226 | 6.16283 | 47 |
| 14 | .09159 | 10.9178 | .10922 | 9.15554 | .12692 | 7.87895 | .14470 | 6.91104 | .16256 | 6.15151 | 46 |
| 15 | .09189 | 10.8829 | .10952 | 9.13093 | .12722 | 7.86064 | .14499 | 6.89688 | .16286 | 6.14023 | 45 |
| 16 | .09218 | 10.8483 | .10981 | 9.10646 | .12751 | 7.84242 | .14529 | 6.88278 | .16316 | 6.12899 | 44 |
| 17 | .09247 | 10.8139 | .11011 | 9.08211 | .12781 | 7.82428 | .14559 | 6.86874 | .16346 | 6.11779 | 43 |
| 18 | .09277 | 10.7797 | .11040 | 9.05789 | .12810 | 7.80622 | .14588 | 6.85475 | .16376 | 6.10664 | 42 |
| 19 | .09306 | 10.7457 | .11070 | 9.03379 | .12840 | 7.78825 | .14618 | 6.84082 | .16405 | 6.09552 | 41 |
| 20 | .09335 | 10.7119 | .11099 | 9.00983 | .12869 | 7.77035 | .14648 | 6.82694 | .16435 | 6.08444 | 40 |
| 21 | .09365 | 10.6783 | .11128 | 8.98598 | .12899 | 7.75254 | .14678 | 6.81312 | .16465 | 6.07340 | 39 |
| 22 | .09394 | 10.6450 | .11158 | 8.96227 | .12929 | 7.73480 | .14707 | 6.79936 | .16495 | 6.06240 | 38 |
| 23 | .09423 | 10.6118 | .11187 | 8.93867 | .12958 | 7.71715 | .14737 | 6.78564 | .16525 | 6.05143 | 37 |
| 24 | .09453 | 10.5789 | .11217 | 8.91520 | .12988 | 7.69957 | .14767 | 6.77199 | .16555 | 6.04051 | 36 |
| 25 | .09482 | 10.5462 | .11246 | 8.89185 | .13017 | 7.68208 | .14796 | 6.75838 | .16585 | 6.02962 | 35 |
| 26 | .09511 | 10.5136 | .11276 | 8.86862 | .13047 | 7.66466 | .14826 | 6.74483 | .16615 | 6.01878 | 34 |
| 27 | .09541 | 10.4813 | .11305 | 8.84551 | .13076 | 7.64732 | .14856 | 6.73133 | .16645 | 6.00797 | 33 |
| 28 | .09570 | 10.4491 | .11335 | 8.82252 | .13106 | 7.63005 | .14886 | 6.71789 | .16674 | 5.99720 | 32 |
| 29 | .09600 | 10.4172 | .11364 | 8.79964 | .13136 | 7.61287 | .14915 | 6.70450 | .16704 | 5.98646 | 31 |
| 30 | .09629 | 10.3854 | .11394 | 8.77689 | .13165 | 7.59575 | .14945 | 6.69116 | .16734 | 5.97576 | 30 |
| 31 | .09658 | 10.3538 | .11423 | 8.75425 | .13195 | 7.57872 | .14975 | 6.67787 | .16764 | 5.96510 | 29 |
| 32 | .09688 | 10.3224 | .11452 | 8.73172 | .13224 | 7.56176 | .15005 | 6.66463 | .16794 | 5.95448 | 28 |
| 33 | .09717 | 10.2913 | .11482 | 8.70931 | .13254 | 7.54487 | .15034 | 6.65144 | .16824 | 5.94390 | 27 |
| 34 | .09746 | 10.2602 | .11511 | 8.68701 | .13284 | 7.52806 | .15064 | 6.63831 | .16854 | 5.93335 | 26 |
| 35 | .09776 | 10.2294 | .11541 | 8.66482 | .13313 | 7.51132 | .15094 | 6.62523 | .16884 | 5.92283 | 25 |
| 36 | .09805 | 10.1988 | .11570 | 8.64275 | .13343 | 7.49465 | .15124 | 6.61219 | .16914 | 5.91236 | 24 |
| 37 | .09834 | 10.1683 | .11600 | 8.62078 | .13372 | 7.47806 | .15153 | 6.59921 | .16944 | 5.90191 | 23 |
| 38 | .09864 | 10.1381 | .11629 | 8.59893 | .13402 | 7.46154 | .15183 | 6.58627 | .16974 | 5.89151 | 22 |
| 39 | .09893 | 10.1080 | .11659 | 8.57718 | .13432 | 7.44509 | .15213 | 6.57339 | .17004 | 5.88114 | 21 |
| 40 | .09923 | 10.0780 | .11688 | 8.55555 | .13461 | 7.42871 | .15243 | 6.56055 | .17033 | 5.87080 | 20 |
| 41 | .09952 | 10.0483 | .11718 | 8.53402 | .13491 | 7.41240 | .15272 | 6.54777 | .17063 | 5.86051 | 19 |
| 42 | .09981 | 10.0187 | .11747 | 8.51259 | .13521 | 7.39616 | .15302 | 6.53503 | .17093 | 5.85024 | 18 |
| 43 | .10011 | 9.98931 | .11777 | 8.49128 | .13550 | 7.37999 | .15332 | 6.52234 | .17123 | 5.84001 | 17 |
| 44 | .10040 | 9.96007 | .11806 | 8.47007 | .13580 | 7.36389 | .15362 | 6.50970 | .17153 | 5.82982 | 16 |
| 45 | .10069 | 9.93101 | .11836 | 8.44896 | .13609 | 7.34786 | .15391 | 6.49710 | .17183 | 5.81966 | 15 |
| 46 | .10099 | 9.90211 | .11865 | 8.42795 | .13639 | 7.33190 | .15421 | 6.48456 | .17213 | 5.80953 | 14 |
| 47 | .10128 | 9.87338 | .11895 | 8.40705 | .13669 | 7.31600 | .15451 | 6.47206 | .17243 | 5.79944 | 13 |
| 48 | .10158 | 9.84482 | .11924 | 8.38625 | .13698 | 7.30018 | .15481 | 6.45961 | .17273 | 5.78938 | 12 |
| 49 | .10187 | 9.81641 | .11954 | 8.36555 | .13728 | 7.28442 | .15511 | 6.44720 | .17303 | 5.77936 | 11 |
| 50 | .10216 | 9.78817 | .11983 | 8.34496 | .13758 | 7.26873 | .15540 | 6.43484 | .17333 | 5.76937 | 10 |
| 51 | .10246 | 9.76009 | .12013 | 8.32446 | .13787 | 7.25310 | .15570 | 6.42253 | .17363 | 5.75941 | 9 |
| 52 | .10275 | 9.73217 | .12042 | 8.30406 | .13817 | 7.23754 | .15600 | 6.41026 | .17393 | 5.74949 | 8 |
| 53 | .10305 | 9.70441 | .12072 | 8.28376 | .13846 | 7.22204 | .15630 | 6.39804 | .17423 | 5.73960 | 7 |
| 54 | .10334 | 9.67680 | .12101 | 8.26355 | .13876 | 7.20661 | .15660 | 6.38587 | .17453 | 5.72974 | 6 |
| 55 | .10363 | 9.64935 | .12131 | 8.24345 | .13906 | 7.19125 | .15689 | 6.37374 | .17483 | 5.71992 | 5 |
| 56 | .10393 | 9.62205 | .12160 | 8.22344 | .13935 | 7.17594 | .15719 | 6.36165 | .17513 | 5.71013 | 4 |
| 57 | .10422 | 9.59490 | .12190 | 8.20352 | .13965 | 7.16071 | .15749 | 6.34961 | .17543 | 5.70037 | 3 |
| 58 | .10452 | 9.56791 | .12219 | 8.18370 | .13995 | 7.14553 | .15779 | 6.33761 | .17573 | 5.69064 | 2 |
| 59 | .10481 | 9.54106 | .12249 | 8.16398 | .14024 | 7.13042 | .15809 | 6.32566 | .17603 | 5.68094 | 1 |
| 60 | .10510 | 9.51436 | .12278 | 8.14435 | .14054 | 7.11537 | .15838 | 6.31375 | .17633 | 5.67128 | 0 |
| ′ | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | ′ |
| | 84° | | 83° | | 82° | | 81° | | 80° | | |

| ′ | 10° | | 11° | | 12° | | 13° | | 14° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | |
| 0 | .17633 | 5.67128 | .19438 | 5.14455 | .21256 | 4.70463 | .23087 | 4.33148 | .24933 | 4.01078 | 60 |
| 1 | .17663 | 5.66165 | .19468 | 5.13658 | .21286 | 4.69791 | .23117 | 4.32573 | .24964 | 4.00582 | 59 |
| 2 | .17693 | 5.65205 | .19498 | 5.12862 | .21316 | 4.69121 | .23148 | 4.32001 | .24995 | 4.00086 | 58 |
| 3 | .17723 | 5.64248 | .19529 | 5.12069 | .21347 | 4.68452 | .23179 | 4.31430 | .25026 | 3.99592 | 57 |
| 4 | .17753 | 5.63295 | .19559 | 5.11279 | .21377 | 4.67786 | .23209 | 4.30860 | .25056 | 3.99099 | 56 |
| 5 | .17783 | 5.62344 | .19589 | 5.10490 | .21408 | 4.67121 | .23240 | 4.30291 | .25087 | 3.98607 | 55 |
| 6 | .17813 | 5.61397 | .19619 | 5.09704 | .21438 | 4.66458 | .23271 | 4.29724 | .25118 | 3.98117 | 54 |
| 7 | .17843 | 5.60452 | .19649 | 5.08921 | .21469 | 4.65797 | .23301 | 4.29159 | .25149 | 3.97627 | 53 |
| 8 | .17873 | 5.59511 | .19680 | 5.08139 | .21499 | 4.65138 | .23332 | 4.28595 | .25180 | 3.97139 | 52 |
| 9 | .17903 | 5.58573 | .19710 | 5.07360 | .21529 | 4.64480 | .23363 | 4.28032 | .25211 | 3.96651 | 51 |
| 10 | .17933 | 5.57638 | .19740 | 5.06584 | .21560 | 4.63825 | .23393 | 4.27471 | .25242 | 3.96165 | 50 |
| 11 | .17963 | 5.56706 | .19770 | 5.05809 | .21590 | 4.63171 | .23424 | 4.26911 | .25273 | 3.95680 | 49 |
| 12 | .17993 | 5.55777 | .19801 | 5.05037 | .21621 | 4.62518 | .23455 | 4.26352 | .25304 | 3.95196 | 48 |
| 13 | .18023 | 5.54851 | .19831 | 5.04267 | .21651 | 4.61868 | .23485 | 4.25795 | .25335 | 3.94713 | 47 |
| 14 | .18053 | 5.53927 | .19861 | 5.03499 | .21682 | 4.61219 | .23516 | 4.25239 | .25366 | 3.94232 | 46 |
| 15 | .18083 | 5.53007 | .19891 | 5.02734 | .21712 | 4.60572 | .23547 | 4.24685 | .25397 | 3.93751 | 45 |
| 16 | .18113 | 5.52090 | .19921 | 5.01971 | .21743 | 4.59927 | .23578 | 4.24132 | .25428 | 3.93271 | 44 |
| 17 | .18143 | 5.51176 | .19952 | 5.01210 | .21773 | 4.59283 | .23608 | 4.23580 | .25459 | 3.92793 | 43 |
| 18 | .18173 | 5.50264 | .19982 | 5.00451 | .21804 | 4.58641 | .23639 | 4.23030 | .25490 | 3.92316 | 42 |
| 19 | .18203 | 5.49356 | .20012 | 4.99695 | .21834 | 4.58001 | .23670 | 4.22481 | .25521 | 3.91839 | 41 |
| 20 | .18233 | 5.48451 | .20042 | 4.98940 | .21864 | 4.57363 | .23700 | 4.21933 | .25552 | 3.91364 | 40 |
| 21 | .18263 | 5.47548 | .20073 | 4.98188 | .21895 | 4.56726 | .23731 | 4.21387 | .25583 | 3.90890 | 39 |
| 22 | .18293 | 5.46648 | .20103 | 4.97438 | .21925 | 4.56091 | .23762 | 4.20842 | .25614 | 3.90417 | 38 |
| 23 | .18323 | 5.45751 | .20133 | 4.96690 | .21956 | 4.55458 | .23793 | 4.20298 | .25645 | 3.89945 | 37 |
| 24 | .18353 | 5.44857 | .20164 | 4.95945 | .21986 | 4.54826 | .23823 | 4.19756 | .25676 | 3.89474 | 36 |
| 25 | .18384 | 5.43966 | .20194 | 4.95201 | .22017 | 4.54196 | .23854 | 4.19215 | .25707 | 3.89004 | 35 |
| 26 | .18414 | 5.43077 | .20224 | 4.94460 | .22047 | 4.53568 | .23885 | 4.18675 | .25738 | 3.88536 | 34 |
| 27 | .18444 | 5.42192 | .20254 | 4.93721 | .22078 | 4.52941 | .23916 | 4.18137 | .25769 | 3.88068 | 33 |
| 28 | .18474 | 5.41309 | .20285 | 4.92984 | .22108 | 4.52316 | .23946 | 4.17600 | .25800 | 3.87601 | 32 |
| 29 | .18504 | 5.40429 | .20315 | 4.92249 | .22139 | 4.51693 | .23977 | 4.17064 | .25831 | 3.87136 | 31 |
| 30 | .18534 | 5.39552 | .20345 | 4.91516 | .22169 | 4.51071 | .24008 | 4.16530 | .25862 | 3.86671 | 30 |
| 31 | .18564 | 5.38677 | .20376 | 4.90785 | .22200 | 4.50451 | .24039 | 4.15997 | .25893 | 3.86208 | 29 |
| 32 | .18594 | 5.37805 | .20406 | 4.90056 | .22231 | 4.49832 | .24069 | 4.15465 | .25924 | 3.85745 | 28 |
| 33 | .18624 | 5.36936 | .20436 | 4.89330 | .22261 | 4.49215 | .24100 | 4.14934 | .25955 | 3.85284 | 27 |
| 34 | .18654 | 5.36070 | .20466 | 4.88605 | .22292 | 4.48600 | .24131 | 4.14405 | .25986 | 3.84824 | 26 |
| 35 | .18684 | 5.35206 | .20497 | 4.87882 | .22322 | 4.47986 | .24162 | 4.13877 | .26017 | 3.84364 | 25 |
| 36 | .18714 | 5.34345 | .20527 | 4.87162 | .22353 | 4.47374 | .24193 | 4.13350 | .26048 | 3.83906 | 24 |
| 37 | .18745 | 5.33487 | .20557 | 4.86444 | .22383 | 4.46764 | .24223 | 4.12825 | .26079 | 3.83449 | 23 |
| 38 | .18775 | 5.32631 | .20588 | 4.85727 | .22414 | 4.46155 | .24254 | 4.12301 | .26110 | 3.82992 | 22 |
| 39 | .18805 | 5.31778 | .20618 | 4.85013 | .22444 | 4.45548 | .24285 | 4.11778 | .26141 | 3.82537 | 21 |
| 40 | .18835 | 5.30928 | .20648 | 4.84300 | .22475 | 4.44942 | .24316 | 4.11256 | .26172 | 3.82083 | 20 |
| 41 | .18865 | 5.30080 | .20679 | 4.83590 | .22505 | 4.44338 | .24347 | 4.10736 | .26203 | 3.81630 | 19 |
| 42 | .18895 | 5.29235 | .20709 | 4.82882 | .22536 | 4.43735 | .24377 | 4.10216 | .26235 | 3.81177 | 18 |
| 43 | .18925 | 5.28393 | .20739 | 4.82175 | .22567 | 4.43134 | .24408 | 4.09699 | .26266 | 3.80726 | 17 |
| 44 | .18955 | 5.27553 | .20770 | 4.81471 | .22597 | 4.42534 | .24439 | 4.09182 | .26297 | 3.80276 | 16 |
| 45 | .18986 | 5.26715 | .20800 | 4.80769 | .22628 | 4.41936 | .24470 | 4.08666 | .26328 | 3.79827 | 15 |
| 46 | .19016 | 5.25880 | .20830 | 4.80068 | .22658 | 4.41340 | .24501 | 4.08152 | .26359 | 3.79378 | 14 |
| 47 | .19046 | 5.25048 | .20861 | 4.79370 | .22689 | 4.40745 | .24532 | 4.07639 | .26390 | 3.78931 | 13 |
| 48 | .19076 | 5.24218 | .20891 | 4.78673 | .22719 | 4.40152 | .24562 | 4.07127 | .26421 | 3.78485 | 12 |
| 49 | .19106 | 5.23391 | .20921 | 4.77978 | .22750 | 4.39560 | .24593 | 4.06616 | .26452 | 3.78040 | 11 |
| 50 | .19136 | 5.22566 | .20952 | 4.77286 | .22781 | 4.38969 | .24624 | 4.06107 | .26483 | 3.77595 | 10 |
| 51 | .19166 | 5.21744 | .20982 | 4.76595 | .22811 | 4.38381 | .24655 | 4.05599 | .26515 | 3.77152 | 9 |
| 52 | .19197 | 5.20925 | .21013 | 4.75906 | .22842 | 4.37793 | .24686 | 4.05092 | .26546 | 3.76709 | 8 |
| 53 | .19227 | 5.20107 | .21043 | 4.75219 | .22872 | 4.37207 | .24717 | 4.04586 | .26577 | 3.76268 | 7 |
| 54 | .19257 | 5.19293 | .21073 | 4.74534 | .22903 | 4.36623 | .24747 | 4.04081 | .26608 | 3.75828 | 6 |
| 55 | .19287 | 5.18480 | .21104 | 4.73851 | .22934 | 4.36040 | .24778 | 4.03578 | .26639 | 3.75388 | 5 |
| 56 | .19317 | 5.17671 | .21134 | 4.73170 | .22964 | 4.35459 | .24809 | 4.03076 | .26670 | 3.74950 | 4 |
| 57 | .19347 | 5.16863 | .21164 | 4.72490 | .22995 | 4.34879 | .24840 | 4.02574 | .26701 | 3.74512 | 3 |
| 58 | .19378 | 5.16058 | .21195 | 4.71813 | .23026 | 4.34300 | .24871 | 4.02074 | .26733 | 3.74075 | 2 |
| 59 | .19408 | 5.15256 | .21225 | 4.71137 | .23056 | 4.33723 | .24902 | 4.01576 | .26764 | 3.73640 | 1 |
| 60 | .19438 | 5.14455 | .21256 | 4.70463 | .23087 | 4.33148 | .24933 | 4.01078 | .26795 | 3.73205 | 0 |
| ′ | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | ′ |
| | 79° | | 78° | | 77° | | 76° | | 75° | | |

| ′ | 15° | | 16° | | 17° | | 18° | | 19° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | |
| 0 | .26795 | 3.73205 | .28675 | 3.48741 | .30573 | 3.27085 | .32492 | 3.07768 | .34433 | 2.90421 | 60 |
| 1 | .26820 | 3.72771 | .28706 | 3.48359 | .30605 | 3.26745 | .32524 | 3.07464 | .34465 | 2.90147 | 59 |
| 2 | .26857 | 3.72338 | .28738 | 3.47977 | .30637 | 3.26406 | .32556 | 3.07160 | .34498 | 2.89873 | 58 |
| 3 | .26888 | 3.71907 | .28769 | 3.47596 | .30669 | 3.26067 | .32588 | 3.06857 | .34530 | 2.89600 | 57 |
| 4 | .26920 | 3.71476 | .28800 | 3.47216 | .30700 | 3.25729 | .32621 | 3.06554 | .34563 | 2.89327 | 56 |
| 5 | .26951 | 3.71046 | .28832 | 3.46837 | .30732 | 3.25392 | .32653 | 3.06252 | .34596 | 2.89055 | 55 |
| 6 | .26982 | 3.70616 | .28864 | 3.46458 | .30764 | 3.25055 | .32685 | 3.05950 | .34628 | 2.88783 | 54 |
| 7 | .27013 | 3.70188 | .28895 | 3.46080 | .30796 | 3.24719 | .32717 | 3.05649 | .34661 | 2.88511 | 53 |
| 8 | .27044 | 3.69761 | .28927 | 3.45703 | .30828 | 3.24383 | .32749 | 3.05349 | .34693 | 2.88240 | 52 |
| 9 | .27076 | 3.69335 | .28958 | 3.45327 | .30860 | 3.24049 | .32782 | 3.05049 | .34726 | 2.87970 | 51 |
| 10 | .27107 | 3.68909 | .28990 | 3.44951 | .30891 | 3.23714 | .32814 | 3.04749 | .34758 | 2.87700 | 50 |
| 11 | .27138 | 3.68485 | .29021 | 3.44576 | .30923 | 3.23381 | .32846 | 3.04450 | .34791 | 2.87430 | 49 |
| 12 | .27169 | 3.68061 | .29053 | 3.44202 | .30955 | 3.23048 | .32878 | 3.04152 | .34824 | 2.87161 | 48 |
| 13 | .27201 | 3.67638 | .29084 | 3.43829 | .30987 | 3.22715 | .32911 | 3.03854 | .34856 | 2.86892 | 47 |
| 14 | .27232 | 3.67217 | .29116 | 3.43456 | .31019 | 3.22384 | .32943 | 3.03556 | .34889 | 2.86624 | 46 |
| 15 | .27263 | 3.66796 | .29147 | 3.43084 | .31051 | 3.22053 | .32975 | 3.03260 | .34922 | 2.86356 | 45 |
| 16 | .27294 | 3.66376 | .29179 | 3.42713 | .31083 | 3.21722 | .33007 | 3.02963 | .34954 | 2.86089 | 44 |
| 17 | .27326 | 3.65957 | .29210 | 3.42343 | .31115 | 3.21392 | .33040 | 3.02667 | .34987 | 2.85822 | 43 |
| 18 | .27357 | 3.65538 | .29242 | 3.41973 | .31147 | 3.21063 | .33072 | 3.02372 | .35020 | 2.85555 | 42 |
| 19 | .27388 | 3.65121 | .29274 | 3.41604 | .31178 | 3.20734 | .33104 | 3.02077 | .35052 | 2.85289 | 41 |
| 20 | .27419 | 3.64705 | .29305 | 3.41236 | .31210 | 3.20406 | .33136 | 3.01783 | .35085 | 2.85023 | 40 |
| 21 | .27451 | 3.64289 | .29337 | 3.40869 | .31242 | 3.20079 | .33169 | 3.01489 | .35118 | 2.84758 | 39 |
| 22 | .27482 | 3.63874 | .29368 | 3.40502 | .31274 | 3.19752 | .33201 | 3.01196 | .35150 | 2.84494 | 38 |
| 23 | .27513 | 3.63461 | .29400 | 3.40136 | .31306 | 3.19426 | .33233 | 3.00903 | .35183 | 2.84229 | 37 |
| 24 | .27545 | 3.63048 | .29432 | 3.39771 | .31338 | 3.19100 | .33266 | 3.00611 | .35216 | 2.83965 | 36 |
| 25 | .27576 | 3.62636 | .29463 | 3.39406 | .31370 | 3.18775 | .33298 | 3.00319 | .35248 | 2.83702 | 35 |
| 26 | .27607 | 3.62224 | .29495 | 3.39042 | .31402 | 3.18451 | .33330 | 3.00028 | .35281 | 2.83439 | 34 |
| 27 | .27638 | 3.61814 | .29526 | 3.38679 | .31434 | 3.18127 | .33363 | 2.99738 | .35314 | 2.83176 | 33 |
| 28 | .27670 | 3.61405 | .29558 | 3.38317 | .31466 | 3.17804 | .33395 | 2.99447 | .35346 | 2.82914 | 32 |
| 29 | .27701 | 3.60996 | .29590 | 3.37955 | .31498 | 3.17481 | .33427 | 2.99158 | .35379 | 2.82653 | 31 |
| 30 | .27732 | 3.60588 | .29621 | 3.37594 | .31530 | 3.17159 | .33460 | 2.98868 | .35412 | 2.82391 | 30 |
| 31 | .27764 | 3.60181 | .29653 | 3.37234 | .31562 | 3.16838 | .33492 | 2.98580 | .35445 | 2.82130 | 29 |
| 32 | .27795 | 3.59775 | .29685 | 3.36875 | .31594 | 3.16517 | .33524 | 2.98292 | .35477 | 2.81870 | 28 |
| 33 | .27826 | 3.59370 | .29716 | 3.36516 | .31626 | 3.16197 | .33557 | 2.98004 | .35510 | 2.81610 | 27 |
| 34 | .27858 | 3.58966 | .29748 | 3.36158 | .31658 | 3.15877 | .33589 | 2.97717 | .35543 | 2.81350 | 26 |
| 35 | .27889 | 3.58562 | .29780 | 3.35800 | .31690 | 3.15558 | .33621 | 2.97430 | .35576 | 2.81091 | 25 |
| 36 | .27921 | 3.58160 | .29811 | 3.35443 | .31722 | 3.15240 | .33654 | 2.97144 | .35608 | 2.80833 | 24 |
| 37 | .27952 | 3.57758 | .29843 | 3.35087 | .31754 | 3.14922 | .33686 | 2.96858 | .35641 | 2.80574 | 23 |
| 38 | .27983 | 3.57357 | .29875 | 3.34732 | .31786 | 3.14605 | .33718 | 2.96573 | .35674 | 2.80316 | 22 |
| 39 | .28015 | 3.56957 | .29906 | 3.34377 | .31818 | 3.14288 | .33751 | 2.96288 | .35707 | 2.80059 | 21 |
| 40 | .28046 | 3.56557 | .29938 | 3.34023 | .31850 | 3.13972 | .33783 | 2.96004 | .35740 | 2.79802 | 20 |
| 41 | .28077 | 3.56159 | .29970 | 3.33670 | .31882 | 3.13656 | .33816 | 2.95721 | .35772 | 2.79545 | 19 |
| 42 | .28109 | 3.55761 | .30001 | 3.33317 | .31914 | 3.13341 | .33848 | 2.95437 | .35805 | 2.79289 | 18 |
| 43 | .28140 | 3.55364 | .30033 | 3.32965 | .31946 | 3.13027 | .33881 | 2.95155 | .35838 | 2.79033 | 17 |
| 44 | .28172 | 3.54968 | .30065 | 3.32614 | .31978 | 3.12713 | .33913 | 2.94872 | .35871 | 2.78778 | 16 |
| 45 | .28203 | 3.54573 | .30097 | 3.32264 | .32010 | 3.12400 | .33945 | 2.94591 | .35904 | 2.78523 | 15 |
| 46 | .28234 | 3.54179 | .30128 | 3.31914 | .32042 | 3.12087 | .33978 | 2.94309 | .35937 | 2.78269 | 14 |
| 47 | .28266 | 3.53785 | .30160 | 3.31565 | .32074 | 3.11775 | .34010 | 2.94028 | .35969 | 2.78014 | 13 |
| 48 | .28297 | 3.53393 | .30192 | 3.31216 | .32106 | 3.11464 | .34043 | 2.93748 | .36002 | 2.77761 | 12 |
| 49 | .28329 | 3.53001 | .30224 | 3.30868 | .32139 | 3.11153 | .34075 | 2.93468 | .36035 | 2.77507 | 11 |
| 50 | .28360 | 3.52609 | .30255 | 3.30521 | .32171 | 3.10842 | .34108 | 2.93189 | .36068 | 2.77254 | 10 |
| 51 | .28391 | 3.52219 | .30287 | 3.30174 | .32203 | 3.10532 | .34140 | 2.92910 | .36101 | 2.77002 | 9 |
| 52 | .28423 | 3.51829 | .30319 | 3.29829 | .32235 | 3.10223 | .34173 | 2.92632 | .36134 | 2.76750 | 8 |
| 53 | .28454 | 3.51441 | .30351 | 3.29483 | .32267 | 3.09914 | .34205 | 2.92354 | .36167 | 2.76498 | 7 |
| 54 | .28486 | 3.51053 | .30382 | 3.29139 | .32299 | 3.09606 | .34238 | 2.92076 | .36199 | 2.76247 | 6 |
| 55 | .28517 | 3.50666 | .30414 | 3.28795 | .32331 | 3.09298 | .34270 | 2.91799 | .36232 | 2.75996 | 5 |
| 56 | .28549 | 3.50279 | .30446 | 3.28452 | .32363 | 3.08991 | .34303 | 2.91523 | .36265 | 2.75746 | 4 |
| 57 | .28580 | 3.49894 | .30478 | 3.28109 | .32396 | 3.08685 | .34335 | 2.91246 | .36298 | 2.75496 | 3 |
| 58 | .28612 | 3.49509 | .30509 | 3.27767 | .32428 | 3.08379 | .34368 | 2.90971 | .36331 | 2.75246 | 2 |
| 59 | .28643 | 3.49125 | .30541 | 3.27426 | .32460 | 3.08073 | .34400 | 2.90696 | .36364 | 2.74997 | 1 |
| 60 | .28675 | 3.48741 | .30573 | 3.27085 | .32492 | 3.07768 | .34433 | 2.90421 | .36397 | 2.74748 | 0 |
| ′ | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | ′ |
| | 74° | | 73° | | 72° | | 71° | | 70° | | |

| ′ | 20° | | 21° | | 22° | | 23° | | 24° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | |
| 0 | .36397 | 2.74748 | .38386 | 2.60509 | .40403 | 2.47509 | .42447 | 2.35585 | .44523 | 2.24604 | 60 |
| 1 | .36430 | 2.74499 | .38420 | 2.60283 | .40436 | 2.47302 | .42482 | 2.35395 | .44558 | 2.24428 | 59 |
| 2 | .36463 | 2.74251 | .38453 | 2.60057 | .40470 | 2.47095 | .42516 | 2.35205 | .44593 | 2.24252 | 58 |
| 3 | .36496 | 2.74004 | .38487 | 2.59831 | .40504 | 2.46888 | .42551 | 2.35015 | .44627 | 2.24077 | 57 |
| 4 | .36529 | 2.73756 | .38520 | 2.59606 | .40538 | 2.46682 | .42585 | 2.34825 | .44662 | 2.23902 | 56 |
| 5 | .36562 | 2.73509 | .38553 | 2.59381 | .40572 | 2.46476 | .42619 | 2.34636 | .44697 | 2.23727 | 55 |
| 6 | .36595 | 2.73263 | .38587 | 2.59156 | .40606 | 2.46270 | .42654 | 2.34447 | .44732 | 2.23553 | 54 |
| 7 | .36628 | 2.73017 | .38620 | 2.58932 | .40640 | 2.46065 | .42688 | 2.34258 | .44767 | 2.23378 | 53 |
| 8 | .36661 | 2.72771 | .38654 | 2.58708 | .40674 | 2.45860 | .42722 | 2.34069 | .44802 | 2.23204 | 52 |
| 9 | .36694 | 2.72526 | .38687 | 2.58484 | .40707 | 2.45655 | .42757 | 2.33881 | .44837 | 2.23030 | 51 |
| 10 | .36727 | 2.72281 | .38721 | 2.58261 | .40741 | 2.45451 | .42791 | 2.33693 | .44872 | 2.22857 | 50 |
| 11 | .36760 | 2.72035 | .38754 | 2.58038 | .40775 | 2.45246 | .42826 | 2.33505 | .44907 | 2.22683 | 49 |
| 12 | .36793 | 2.71792 | .38787 | 2.57815 | .40809 | 2.45043 | .42860 | 2.33317 | .44942 | 2.22510 | 48 |
| 13 | .36826 | 2.71548 | .38821 | 2.57593 | .40843 | 2.44839 | .42894 | 2.33130 | .44977 | 2.22337 | 47 |
| 14 | .36859 | 2.71305 | .38854 | 2.57371 | .40877 | 2.44636 | .42929 | 2.32943 | .45012 | 2.22164 | 46 |
| 15 | .36892 | 2.71062 | .38888 | 2.57150 | .40911 | 2.44433 | .42963 | 2.32756 | .45047 | 2.21992 | 45 |
| 16 | .36925 | 2.70819 | .38921 | 2.56928 | .40945 | 2.44230 | .42998 | 2.32570 | .45082 | 2.21819 | 44 |
| 17 | .36958 | 2.70577 | .38955 | 2.56707 | .40979 | 2.44027 | .43032 | 2.32383 | .45117 | 2.21647 | 43 |
| 18 | .36991 | 2.70335 | .38988 | 2.56487 | .41013 | 2.43825 | .43067 | 2.32197 | .45152 | 2.21475 | 42 |
| 19 | .37024 | 2.70094 | .39022 | 2.56266 | .41047 | 2.43623 | .43101 | 2.32012 | .45187 | 2.21304 | 41 |
| 20 | .37057 | 2.69853 | .39055 | 2.56046 | .41081 | 2.43422 | .43136 | 2.31826 | .45222 | 2.21132 | 40 |
| 21 | .37090 | 2.69612 | .39089 | 2.55827 | .41115 | 2.43220 | .43170 | 2.31641 | .45257 | 2.20961 | 39 |
| 22 | .37123 | 2.69371 | .39122 | 2.55608 | .41149 | 2.43019 | .43205 | 2.31456 | .45292 | 2.20790 | 38 |
| 23 | .37157 | 2.69131 | .39156 | 2.55389 | .41183 | 2.42819 | .43230 | 2.31271 | .45327 | 2.20619 | 37 |
| 24 | .37190 | 2.68892 | .39190 | 2.55170 | .41217 | 2.42618 | .43274 | 2.31086 | .45362 | 2.20449 | 36 |
| 25 | .37223 | 2.68653 | .39223 | 2.54952 | .41251 | 2.42418 | .43308 | 2.30902 | .45397 | 2.20278 | 35 |
| 26 | .37256 | 2.68414 | .39257 | 2.54734 | .41285 | 2.42218 | .43343 | 2.30718 | .45432 | 2.20108 | 34 |
| 27 | .37289 | 2.68175 | .39290 | 2.54516 | .41319 | 2.42019 | .43378 | 2.30534 | .45467 | 2.19938 | 33 |
| 28 | .37322 | 2.67937 | .39324 | 2.54299 | .41353 | 2.41819 | .43412 | 2.30351 | .45502 | 2.19769 | 32 |
| 29 | .37355 | 2.67700 | .39357 | 2.54082 | .41387 | 2.41620 | .43447 | 2.30167 | .45538 | 2.19599 | 31 |
| 30 | .37388 | 2.67462 | .39391 | 2.53865 | .41421 | 2.41421 | .43481 | 2.29984 | .45573 | 2.19430 | 30 |
| 31 | .37422 | 2.67225 | .39425 | 2.53648 | .41455 | 2.41223 | .43516 | 2.29801 | .45608 | 2.19261 | 29 |
| 32 | .37455 | 2.66989 | .39458 | 2.53432 | .41490 | 2.41025 | .43550 | 2.29619 | .45643 | 2.19092 | 28 |
| 33 | .37488 | 2.66752 | .39492 | 2.53217 | .41524 | 2.40827 | .43585 | 2.29437 | .45678 | 2.18923 | 27 |
| 34 | .37521 | 2.66516 | .39526 | 2.53001 | .41558 | 2.40629 | .43620 | 2.29254 | .45713 | 2.18755 | 26 |
| 35 | .37554 | 2.66281 | .39559 | 2.52786 | .41592 | 2.40432 | .43654 | 2.29073 | .45748 | 2.18587 | 25 |
| 36 | .37588 | 2.66046 | .39593 | 2.52571 | .41626 | 2.40235 | .43689 | 2.28891 | .45784 | 2.18419 | 24 |
| 37 | .37621 | 2.65811 | .39626 | 2.52357 | .41660 | 2.40038 | .43724 | 2.28710 | .45819 | 2.18251 | 23 |
| 38 | .37654 | 2.65576 | .39660 | 2.52142 | .41694 | 2.39841 | .43758 | 2.28528 | .45854 | 2.18084 | 22 |
| 39 | .37687 | 2.65342 | .39694 | 2.51929 | .41728 | 2.39645 | .43793 | 2.28348 | .45889 | 2.17916 | 21 |
| 40 | .37720 | 2.65109 | .39727 | 2.51715 | .41763 | 2.39449 | .43828 | 2.28167 | .45924 | 2.17749 | 20 |
| 41 | .37754 | 2.64875 | .39761 | 2.51502 | .41797 | 2.39253 | .43862 | 2.27987 | .45960 | 2.17582 | 19 |
| 42 | .37787 | 2.64642 | .39795 | 2.51289 | .41831 | 2.39058 | .43897 | 2.27806 | .45995 | 2.17416 | 18 |
| 43 | .37820 | 2.64410 | .39829 | 2.51076 | .41865 | 2.38863 | .43932 | 2.27626 | .46030 | 2.17249 | 17 |
| 44 | .37853 | 2.64177 | .39862 | 2.50864 | .41899 | 2.38668 | .43966 | 2.27447 | .46065 | 2.17083 | 16 |
| 45 | .37887 | 2.63945 | .39896 | 2.50652 | .41933 | 2.38473 | .44001 | 2.27267 | .46101 | 2.16917 | 15 |
| 46 | .37920 | 2.63714 | .39930 | 2.50440 | .41968 | 2.38279 | .44036 | 2.27088 | .46136 | 2.16751 | 14 |
| 47 | .37953 | 2.63483 | .39963 | 2.50229 | .42002 | 2.38084 | .44071 | 2.26909 | .46171 | 2.16585 | 13 |
| 48 | .37986 | 2.63252 | .39997 | 2.50018 | .42036 | 2.37891 | .44105 | 2.26730 | .46206 | 2.16420 | 12 |
| 49 | .38020 | 2.63021 | .40031 | 2.49807 | .42070 | 2.37697 | .44140 | 2.26552 | .46242 | 2.16255 | 11 |
| 50 | .38053 | 2.62791 | .40065 | 2.49597 | .42105 | 2.37504 | .44175 | 2.26374 | .46277 | 2.16090 | 10 |
| 51 | .38086 | 2.62561 | .40098 | 2.49386 | .42139 | 2.37311 | .44210 | 2.26196 | .46312 | 2.15925 | 9 |
| 52 | .38120 | 2.62332 | .40132 | 2.49177 | .42173 | 2.37118 | .44244 | 2.26018 | .46348 | 2.15760 | 8 |
| 53 | .38153 | 2.62103 | .40166 | 2.48967 | .42207 | 2.36925 | .44279 | 2.25840 | .46383 | 2.15596 | 7 |
| 54 | .38186 | 2.61874 | .40200 | 2.48758 | .42242 | 2.36733 | .44314 | 2.25663 | .46418 | 2.15432 | 6 |
| 55 | .38220 | 2.61646 | .40234 | 2.48549 | .42276 | 2.36541 | .44349 | 2.25486 | .46454 | 2.15268 | 5 |
| 56 | .38253 | 2.61418 | .40267 | 2.48340 | .42310 | 2.36349 | .44384 | 2.25309 | .46489 | 2.15104 | 4 |
| 57 | .38286 | 2.61190 | .40301 | 2.48132 | .42345 | 2.36158 | .44418 | 2.25132 | .46525 | 2.14940 | 3 |
| 58 | .38320 | 2.60963 | .40335 | 2.47924 | .42379 | 2.35967 | .44453 | 2.24956 | .46560 | 2.14777 | 2 |
| 59 | .38353 | 2.60736 | .40369 | 2.47716 | .42413 | 2.35776 | .44488 | 2.24780 | .46595 | 2.14614 | 1 |
| 60 | .38386 | 2.60509 | .40403 | 2.47509 | .42447 | 2.35585 | .44523 | 2.24604 | .46631 | 2.14451 | 0 |
| ′ | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | ′ |
| | 69° | | 68° | | 67° | | 66° | | 65° | | |

| ′ | 25° | | 26° | | 27° | | 28° | | 29° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | |
| 0 | .46631 | 2.14451 | .48773 | 2.05030 | .50953 | 1.96261 | .53171 | 1.88073 | .55431 | 1.80405 | 60 |
| 1 | .46666 | 2.14288 | .48809 | 2.04879 | .50989 | 1.96120 | .53208 | 1.87941 | .55469 | 1.80281 | 59 |
| 2 | .46702 | 2.14125 | .48845 | 2.04728 | .51026 | 1.95979 | .53246 | 1.87809 | .55507 | 1.80158 | 58 |
| 3 | .46737 | 2.13963 | .48881 | 2.04577 | .51063 | 1.95838 | .53283 | 1.87677 | .55545 | 1.80034 | 57 |
| 4 | .46772 | 2.13801 | .48917 | 2.04426 | .51099 | 1.95698 | .53320 | 1.87546 | .55583 | 1.79911 | 56 |
| 5 | .46808 | 2.13639 | .48953 | 2.04276 | .51136 | 1.95557 | .53358 | 1.87415 | .55621 | 1.79788 | 55 |
| 6 | .46843 | 2.13477 | .48989 | 2.04125 | .51173 | 1.95417 | .53395 | 1.87283 | .55659 | 1.79665 | 54 |
| 7 | .46879 | 2.13316 | .49026 | 2.03975 | .51209 | 1.95277 | .53432 | 1.87152 | .55697 | 1.79542 | 53 |
| 8 | .46914 | 2.13154 | .49062 | 2.03825 | .51246 | 1.95137 | .53470 | 1.87021 | .55736 | 1.79419 | 52 |
| 9 | .46950 | 2.12993 | .49098 | 2.03675 | .51283 | 1.94997 | .53507 | 1.86891 | .55774 | 1.79296 | 51 |
| 10 | .46985 | 2.12832 | .49134 | 2.03526 | .51319 | 1.94858 | .53545 | 1.86760 | .55812 | 1.79174 | 50 |
| 11 | .47021 | 2.12671 | .49170 | 2.03376 | .51356 | 1.94718 | .53582 | 1.86630 | .55850 | 1.79051 | 49 |
| 12 | .47056 | 2.12511 | .49206 | 2.03227 | .51393 | 1.94579 | .53620 | 1.86499 | .55888 | 1.78929 | 48 |
| 13 | .47092 | 2.12350 | .49242 | 2.03078 | .51430 | 1.94440 | .53657 | 1.86369 | .55926 | 1.78807 | 47 |
| 14 | .47128 | 2.12190 | .49278 | 2.02929 | .51467 | 1.94301 | .53694 | 1.86239 | .55964 | 1.78685 | 46 |
| 15 | .47163 | 2.12030 | .49315 | 2.02780 | .51503 | 1.94162 | .53732 | 1.86109 | .56003 | 1.78563 | 45 |
| 16 | .47199 | 2.11871 | .49351 | 2.02631 | .51540 | 1.94023 | .53769 | 1.85979 | .56041 | 1.78441 | 44 |
| 17 | .47234 | 2.11711 | .49387 | 2.02483 | .51577 | 1.93885 | .53807 | 1.85850 | .56079 | 1.78319 | 43 |
| 18 | .47270 | 2.11552 | .49423 | 2.02335 | .51614 | 1.93746 | .53844 | 1.85720 | .56117 | 1.78198 | 42 |
| 19 | .47305 | 2.11392 | .49459 | 2.02187 | .51651 | 1.93608 | .53882 | 1.85591 | .56156 | 1.78077 | 41 |
| 20 | .47341 | 2.11233 | .49495 | 2.02039 | .51688 | 1.93470 | .53920 | 1.85462 | .56194 | 1.77955 | 40 |
| 21 | .47377 | 2.11075 | .49532 | 2.01891 | .51724 | 1.93332 | .53957 | 1.85333 | .56232 | 1.77834 | 39 |
| 22 | .47412 | 2.10916 | .49568 | 2.01743 | .51761 | 1.93195 | .53995 | 1.85204 | .56270 | 1.77713 | 38 |
| 23 | .47448 | 2.10758 | .49604 | 2.01596 | .51798 | 1.93057 | .54032 | 1.85075 | .56309 | 1.77592 | 37 |
| 24 | .47483 | 2.10600 | .49640 | 2.01449 | .51835 | 1.92920 | .54070 | 1.84946 | .56347 | 1.77471 | 36 |
| 25 | .47519 | 2.10442 | .49677 | 2.01302 | .51872 | 1.92782 | .54107 | 1.84818 | .56385 | 1.77351 | 35 |
| 26 | .47555 | 2.10284 | .49713 | 2.01155 | .51909 | 1.92645 | .54145 | 1.84689 | .56424 | 1.77230 | 34 |
| 27 | .47590 | 2.10126 | .49749 | 2.01008 | .51946 | 1.92508 | .54183 | 1.84561 | .56462 | 1.77110 | 33 |
| 28 | .47626 | 2.09969 | .49786 | 2.00862 | .51983 | 1.92371 | .54220 | 1.84433 | .56501 | 1.76990 | 32 |
| 29 | .47662 | 2.09811 | .49822 | 2.00715 | .52020 | 1.92235 | .54258 | 1.84305 | .56539 | 1.76869 | 31 |
| 30 | .47698 | 2.09654 | .49858 | 2.00569 | .52057 | 1.92098 | .54296 | 1.84177 | .56577 | 1.76749 | 30 |
| 31 | .47733 | 2.09498 | .49894 | 2.00423 | .52094 | 1.91962 | .54333 | 1.84049 | .56616 | 1.76629 | 29 |
| 32 | .47769 | 2.09341 | .49931 | 2.00277 | .52131 | 1.91826 | .54371 | 1.83922 | .56654 | 1.76510 | 28 |
| 33 | .47805 | 2.09184 | .49967 | 2.00131 | .52168 | 1.91690 | .54409 | 1.83794 | .56693 | 1.76390 | 27 |
| 34 | .47840 | 2.09028 | .50004 | 1.99986 | .52205 | 1.91554 | .54446 | 1.83667 | .56731 | 1.76271 | 26 |
| 35 | .47876 | 2.08872 | .50040 | 1.99841 | .52242 | 1.91418 | .54484 | 1.83540 | .56769 | 1.76151 | 25 |
| 36 | .47912 | 2.08716 | .50076 | 1.99695 | .52279 | 1.91282 | .54522 | 1.83413 | .56808 | 1.76032 | 24 |
| 37 | .47948 | 2.08560 | .50113 | 1.99550 | .52316 | 1.91147 | .54560 | 1.83286 | .56846 | 1.75913 | 23 |
| 38 | .47984 | 2.08405 | .50149 | 1.99406 | .52353 | 1.91012 | .54597 | 1.83159 | .56885 | 1.75794 | 22 |
| 39 | .48019 | 2.08250 | .50185 | 1.99261 | .52390 | 1.90876 | .54635 | 1.83033 | .56923 | 1.75675 | 21 |
| 40 | .48055 | 2.08094 | .50222 | 1.99116 | .52427 | 1.90741 | .54673 | 1.82906 | .56962 | 1.75556 | 20 |
| 41 | .48091 | 2.07939 | .50258 | 1.98972 | .52464 | 1.90607 | .54711 | 1.82780 | .57000 | 1.75437 | 19 |
| 42 | .48127 | 2.07785 | .50295 | 1.98828 | .52501 | 1.90472 | .54748 | 1.82654 | .57039 | 1.75319 | 18 |
| 43 | .48163 | 2.07630 | .50331 | 1.98684 | .52538 | 1.90337 | .54786 | 1.82528 | .57078 | 1.75200 | 17 |
| 44 | .48198 | 2.07476 | .50368 | 1.98540 | .52575 | 1.90203 | .54824 | 1.82402 | .57116 | 1.75082 | 16 |
| 45 | .48234 | 2.07321 | .50404 | 1.98396 | .52613 | 1.90069 | .54862 | 1.82276 | .57155 | 1.74964 | 15 |
| 46 | .48270 | 2.07167 | .50441 | 1.98253 | .52650 | 1.89935 | .54900 | 1.82150 | .57193 | 1.74846 | 14 |
| 47 | .48306 | 2.07014 | .50477 | 1.98110 | .52687 | 1.89801 | .54938 | 1.82025 | .57232 | 1.74728 | 13 |
| 48 | .48342 | 2.06860 | .50514 | 1.97966 | .52724 | 1.89667 | .54975 | 1.81899 | .57271 | 1.74610 | 12 |
| 49 | .48378 | 2.06706 | .50550 | 1.97823 | .52761 | 1.89533 | .55013 | 1.81774 | .57309 | 1.74492 | 11 |
| 50 | .48414 | 2.06553 | .50587 | 1.97681 | .52798 | 1.89400 | .55051 | 1.81649 | .57348 | 1.74375 | 10 |
| 51 | .48450 | 2.06400 | .50623 | 1.97538 | .52836 | 1.89266 | .55089 | 1.81524 | .57386 | 1.74257 | 9 |
| 52 | .48486 | 2.06247 | .50660 | 1.97395 | .52873 | 1.89133 | .55127 | 1.81399 | .57425 | 1.74140 | 8 |
| 53 | .48521 | 2.06094 | .50696 | 1.97253 | .52910 | 1.89000 | .55165 | 1.81274 | .57464 | 1.74022 | 7 |
| 54 | .48557 | 2.05942 | .50733 | 1.97111 | .52947 | 1.88867 | .55203 | 1.81150 | .57503 | 1.73905 | 6 |
| 55 | .48593 | 2.05790 | .50769 | 1.96969 | .52985 | 1.88734 | .55241 | 1.81025 | .57541 | 1.73788 | 5 |
| 56 | .48629 | 2.05637 | .50806 | 1.96827 | .53022 | 1.88602 | .55279 | 1.80901 | .57580 | 1.73671 | 4 |
| 57 | .48665 | 2.05485 | .50843 | 1.96685 | .53059 | 1.88469 | .55317 | 1.80777 | .57619 | 1.73555 | 3 |
| 58 | .48701 | 2.05333 | .50879 | 1.96544 | .53096 | 1.88337 | .55355 | 1.80653 | .57657 | 1.73438 | 2 |
| 59 | .48737 | 2.05182 | .50916 | 1.96402 | .53134 | 1.88205 | .55393 | 1.80529 | .57696 | 1.73321 | 1 |
| 60 | .48773 | 2.05030 | .50953 | 1.96261 | .53171 | 1.88073 | .55431 | 1.80405 | .57735 | 1.73205 | 0 |
| ′ | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | ′ |
| | 64° | | 63° | | 62° | | 61° | | 60° | | |

| ′ | 30° | | 31° | | 32° | | 33° | | 34° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | |
| 0 | .57735 | 1.73205 | .60086 | 1.66428 | .62487 | 1.60033 | .64941 | 1.53986 | .67451 | 1.48256 | 60 |
| 1 | .57774 | 1.73089 | .60126 | 1.66318 | .62527 | 1.59930 | .64982 | 1.53888 | .67493 | 1.48163 | 59 |
| 2 | .57813 | 1.72973 | .60165 | 1.66209 | .62568 | 1.59826 | .65024 | 1.53791 | .67536 | 1.48070 | 58 |
| 3 | .57851 | 1.72857 | .60205 | 1.66099 | .62608 | 1.59723 | .65065 | 1.53693 | .67578 | 1.47977 | 57 |
| 4 | .57890 | 1.72741 | .60245 | 1.65990 | .62649 | 1.59620 | .65106 | 1.53595 | .67620 | 1.47885 | 56 |
| 5 | .57929 | 1.72625 | .60284 | 1.65881 | .62689 | 1.59517 | .65148 | 1.53497 | .67663 | 1.47792 | 55 |
| 6 | .57968 | 1.72509 | .60324 | 1.65772 | .62730 | 1.59414 | .65189 | 1.53400 | .67705 | 1.47699 | 54 |
| 7 | .58007 | 1.72393 | .60364 | 1.65663 | .62770 | 1.59311 | .65231 | 1.53302 | .67748 | 1.47607 | 53 |
| 8 | .58046 | 1.72278 | .60403 | 1.65554 | .62811 | 1.59208 | .65272 | 1.53205 | .67790 | 1.47514 | 52 |
| 9 | .58085 | 1.72163 | .60443 | 1.65445 | .62852 | 1.59105 | .65314 | 1.53107 | .67832 | 1.47422 | 51 |
| 10 | .58124 | 1.72047 | .60483 | 1.65337 | .62892 | 1.59002 | .65355 | 1.53010 | .67875 | 1.47330 | 50 |
| 11 | .58162 | 1.71932 | .60522 | 1.65228 | .62933 | 1.58900 | .65397 | 1.52913 | .67917 | 1.47238 | 49 |
| 12 | .58201 | 1.71817 | .60562 | 1.65120 | .62973 | 1.58797 | .65438 | 1.52816 | .67960 | 1.47146 | 48 |
| 13 | .58240 | 1.71702 | .60602 | 1.65011 | .63014 | 1.58695 | .65480 | 1.52719 | .68002 | 1.47053 | 47 |
| 14 | .58279 | 1.71588 | .60642 | 1.64903 | .63055 | 1.58593 | .65521 | 1.52622 | .68045 | 1.46962 | 46 |
| 15 | .58318 | 1.71473 | .60681 | 1.64795 | .63095 | 1.58490 | .65563 | 1.52525 | .68088 | 1.46870 | 45 |
| 16 | .58357 | 1.71358 | .60721 | 1.64687 | .63136 | 1.58388 | .65604 | 1.52429 | .68130 | 1.46778 | 44 |
| 17 | .58396 | 1.71244 | .60761 | 1.64579 | .63177 | 1.58286 | .65646 | 1.52332 | .68173 | 1.46686 | 43 |
| 18 | .58435 | 1.71129 | .60801 | 1.64471 | .63217 | 1.58184 | .65688 | 1.52235 | .68215 | 1.46595 | 42 |
| 19 | .58474 | 1.71015 | .60841 | 1.64363 | .63258 | 1.58083 | .65729 | 1.52139 | .68258 | 1.46503 | 41 |
| 20 | .58513 | 1.70901 | .60881 | 1.64256 | .63299 | 1.57981 | .65771 | 1.52043 | .68301 | 1.46411 | 40 |
| 21 | .58552 | 1.70787 | .60921 | 1.64148 | .63340 | 1.57879 | .65813 | 1.51946 | .68343 | 1.46320 | 39 |
| 22 | .58591 | 1.70673 | .60960 | 1.64041 | .63380 | 1.57778 | .65854 | 1.51850 | .68386 | 1.46229 | 38 |
| 23 | .58631 | 1.70560 | .61000 | 1.63934 | .63421 | 1.57676 | .65896 | 1.51754 | .68429 | 1.46137 | 37 |
| 24 | .58670 | 1.70446 | .61040 | 1.63826 | .63462 | 1.57575 | .65938 | 1.51658 | .68471 | 1.46046 | 36 |
| 25 | .58709 | 1.70332 | .61080 | 1.63719 | .63503 | 1.57474 | .65980 | 1.51562 | .68514 | 1.45955 | 35 |
| 26 | .58748 | 1.70219 | .61120 | 1.63612 | .63544 | 1.57372 | .66021 | 1.51466 | .68557 | 1.45864 | 34 |
| 27 | .58787 | 1.70106 | .61160 | 1.63505 | .63584 | 1.57271 | .66063 | 1.51370 | .68600 | 1.45773 | 33 |
| 28 | .58826 | 1.69992 | .61200 | 1.63398 | .63625 | 1.57170 | .66105 | 1.51275 | .68642 | 1.45682 | 32 |
| 29 | .58865 | 1.69879 | .61240 | 1.63292 | .63666 | 1.57069 | .66147 | 1.51179 | .68685 | 1.45592 | 31 |
| 30 | .58905 | 1.69766 | .61280 | 1.63185 | .63707 | 1.56969 | .66189 | 1.51084 | .68728 | 1.45501 | 30 |
| 31 | .58944 | 1.69653 | .61320 | 1.63079 | .63748 | 1.56868 | .66230 | 1.50988 | .68771 | 1.45410 | 29 |
| 32 | .58983 | 1.69541 | .61360 | 1.62972 | .63789 | 1.56767 | .66272 | 1.50893 | .68814 | 1.45320 | 28 |
| 33 | .59022 | 1.69428 | .61400 | 1.62866 | .63830 | 1.56667 | .66314 | 1.50797 | .68857 | 1.45229 | 27 |
| 34 | .59061 | 1.69316 | .61440 | 1.62760 | .63871 | 1.56566 | .66356 | 1.50702 | .68900 | 1.45139 | 26 |
| 35 | .59101 | 1.69203 | .61480 | 1.62654 | .63912 | 1.56466 | .66398 | 1.50607 | .68942 | 1.45049 | 25 |
| 36 | .59149 | 1.69091 | .61520 | 1.62548 | .63953 | 1.56366 | .66440 | 1.50512 | .68985 | 1.44958 | 24 |
| 37 | .59179 | 1.68979 | .61561 | 1.62442 | .63994 | 1.56265 | .66482 | 1.50417 | .69028 | 1.44868 | 23 |
| 38 | .59218 | 1.68866 | .61601 | 1.62336 | .64035 | 1.56165 | .66524 | 1.50322 | .69071 | 1.44778 | 22 |
| 39 | .59258 | 1.68754 | .61641 | 1.62230 | .64076 | 1.56065 | .66566 | 1.50228 | .69114 | 1.44688 | 21 |
| 40 | .59297 | 1.68643 | .61681 | 1.62125 | .64117 | 1.55966 | .66608 | 1.50133 | .69157 | 1.44598 | 20 |
| 41 | .59336 | 1.68531 | .61721 | 1.62019 | .64158 | 1.55866 | .66650 | 1.50038 | .69200 | 1.44508 | 19 |
| 42 | .59376 | 1.68419 | .61761 | 1.61914 | .64199 | 1.55766 | .66692 | 1.49944 | .69243 | 1.44418 | 18 |
| 43 | .59415 | 1.68308 | .61801 | 1.61808 | .64240 | 1.55666 | .66734 | 1.49849 | .69286 | 1.44329 | 17 |
| 44 | .59454 | 1.68196 | .61842 | 1.61703 | .64281 | 1.55567 | .66776 | 1.49755 | .69329 | 1.44239 | 16 |
| 45 | .59494 | 1.68085 | .61882 | 1.61598 | .64322 | 1.55467 | .66818 | 1.49661 | .69372 | 1.44149 | 15 |
| 46 | .59533 | 1.67974 | .61922 | 1.61493 | .64363 | 1.55368 | .66860 | 1.49566 | .69416 | 1.44060 | 14 |
| 47 | .59573 | 1.67863 | .61962 | 1.61388 | .64404 | 1.55269 | .66902 | 1.49472 | .69459 | 1.43970 | 13 |
| 48 | .59612 | 1.67752 | .62003 | 1.61283 | .64446 | 1.55170 | .66944 | 1.49378 | .69502 | 1.43881 | 12 |
| 49 | .59651 | 1.67641 | .62043 | 1.61179 | .64487 | 1.55071 | .66986 | 1.49284 | .69545 | 1.43792 | 11 |
| 50 | .59691 | 1.67530 | .62083 | 1.61074 | .64528 | 1.54972 | .67028 | 1.49190 | .69588 | 1.43703 | 10 |
| 51 | .59730 | 1.67419 | .62124 | 1.60970 | .64569 | 1.54873 | .67071 | 1.49097 | .69631 | 1.43614 | 9 |
| 52 | .59770 | 1.67309 | .62164 | 1.60865 | .64610 | 1.54774 | .67113 | 1.49003 | .69675 | 1.43525 | 8 |
| 53 | .59809 | 1.67198 | .62204 | 1.60761 | .64652 | 1.54675 | .67155 | 1.48909 | .69718 | 1.43436 | 7 |
| 54 | .59849 | 1.67088 | .62245 | 1.60657 | .64693 | 1.54576 | .67197 | 1.48816 | .69761 | 1.43347 | 6 |
| 55 | .59888 | 1.66978 | .62285 | 1.60553 | .64734 | 1.54478 | .67239 | 1.48722 | .69804 | 1.43258 | 5 |
| 56 | .59928 | 1.66867 | .62325 | 1.60449 | .64775 | 1.54379 | .67282 | 1.48629 | .69847 | 1.43169 | 4 |
| 57 | .59967 | 1.66757 | .62366 | 1.60345 | .64817 | 1.54281 | .67324 | 1.48536 | .69891 | 1.43080 | 3 |
| 58 | .60007 | 1.66647 | .62406 | 1.60241 | .64858 | 1.54183 | .67366 | 1.48442 | .69934 | 1.42992 | 2 |
| 59 | .60046 | 1.66538 | .62446 | 1.60137 | .64899 | 1.54085 | .67409 | 1.48349 | .69977 | 1.42903 | 1 |
| 60 | .60086 | 1.66428 | .62487 | 1.60033 | .64941 | 1.53986 | .67451 | 1.48256 | .70021 | 1.42815 | 0 |
| ′ | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | ′ |
| | 59° | | 58° | | 57° | | 56° | | 55° | | |

| ′ | 35° | | 36° | | 37° | | 38° | | 39° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | |
| 0 | .70021 | 1.42815 | .72654 | 1.37638 | .75355 | 1.32704 | .78129 | 1.27994 | .80978 | 1.23490 | 60 |
| 1 | .70064 | 1.42726 | .72699 | 1.37554 | .75401 | 1.32624 | .78175 | 1.27917 | .81027 | 1.23416 | 59 |
| 2 | .70107 | 1.42638 | .72743 | 1.37470 | .75447 | 1.32544 | .78222 | 1.27841 | .81075 | 1.23343 | 58 |
| 3 | .70151 | 1.42550 | .72788 | 1.37386 | .75492 | 1.32464 | .78269 | 1.27764 | .81123 | 1.23270 | 57 |
| 4 | .70194 | 1.42462 | .72832 | 1.37302 | .75538 | 1.32384 | .78316 | 1.27688 | .81171 | 1.23196 | 56 |
| 5 | .70238 | 1.42374 | .72877 | 1.37218 | .75584 | 1.32304 | .78363 | 1.27611 | .81220 | 1.23123 | 55 |
| 6 | .70281 | 1.42286 | .72921 | 1.37134 | .75629 | 1.32224 | .78410 | 1.27535 | .81268 | 1.23050 | 54 |
| 7 | .70325 | 1.42198 | .72966 | 1.37050 | .75675 | 1.32144 | .78457 | 1.27458 | .81316 | 1.22977 | 53 |
| 8 | .70368 | 1.42110 | .73010 | 1.36967 | .75721 | 1.32064 | .78504 | 1.27382 | .81364 | 1.22904 | 52 |
| 9 | .70412 | 1.42022 | .73055 | 1.36883 | .75767 | 1.31984 | .78551 | 1.27306 | .81413 | 1.22831 | 51 |
| 10 | .70455 | 1.41934 | .73100 | 1.36800 | .75812 | 1.31904 | .78598 | 1.27230 | .81461 | 1.22758 | 50 |
| 11 | .70499 | 1.41847 | .73144 | 1.36716 | .75858 | 1.31825 | .78645 | 1.27153 | .81510 | 1.22685 | 49 |
| 12 | .70542 | 1.41759 | .73189 | 1.36633 | .75904 | 1.31745 | .78692 | 1.27077 | .81558 | 1.22612 | 48 |
| 13 | .70586 | 1.41672 | .73234 | 1.36549 | .75950 | 1.31666 | .78739 | 1.27001 | .81606 | 1.22539 | 47 |
| 14 | .70629 | 1.41584 | .73278 | 1.36466 | .75996 | 1.31586 | .78786 | 1.26925 | .81655 | 1.22467 | 46 |
| 15 | .70673 | 1.41497 | .73323 | 1.36383 | .76042 | 1.31507 | .78834 | 1.26849 | .81703 | 1.22394 | 45 |
| 16 | .70717 | 1.41409 | .73368 | 1.36300 | .76088 | 1.31427 | .78881 | 1.26774 | .81752 | 1.22321 | 44 |
| 17 | .70760 | 1.41322 | .73413 | 1.36217 | .76134 | 1.31348 | .78928 | 1.26698 | .81800 | 1.22249 | 43 |
| 18 | .70804 | 1.41235 | .73457 | 1.36134 | .76180 | 1.31269 | .78975 | 1.26622 | .81849 | 1.22176 | 42 |
| 19 | .70848 | 1.41148 | .73502 | 1.36051 | .76226 | 1.31190 | .79022 | 1.26546 | .81898 | 1.22104 | 41 |
| 20 | .70891 | 1.41061 | .73547 | 1.35968 | .76272 | 1.31110 | .79070 | 1.26471 | .81946 | 1.22031 | 40 |
| 21 | .70935 | 1.40974 | .73592 | 1.35885 | .76318 | 1.31031 | .79117 | 1.26395 | .81995 | 1.21959 | 39 |
| 22 | .70979 | 1.40887 | .73637 | 1.35802 | .76364 | 1.30952 | .79164 | 1.26319 | .82044 | 1.21886 | 38 |
| 23 | .71023 | 1.40800 | .73681 | 1.35719 | .76410 | 1.30873 | .79212 | 1.26244 | .82092 | 1.21814 | 37 |
| 24 | .71066 | 1.40714 | .73726 | 1.35637 | .76456 | 1.30795 | .79259 | 1.26169 | .82141 | 1.21742 | 36 |
| 25 | .71110 | 1.40627 | .73771 | 1.35554 | .76502 | 1.30716 | .79306 | 1.26093 | .82190 | 1.21670 | 35 |
| 26 | .71154 | 1.40540 | .73816 | 1.35472 | .76548 | 1.30637 | .79354 | 1.26018 | .82238 | 1.21598 | 34 |
| 27 | .71198 | 1.40454 | .73861 | 1.35389 | .76594 | 1.30558 | .79401 | 1.25943 | .82287 | 1.21526 | 33 |
| 28 | .71242 | 1.40367 | .73906 | 1.35307 | .76640 | 1.30480 | .79449 | 1.25867 | .82336 | 1.21454 | 32 |
| 29 | .71285 | 1.40281 | .73951 | 1.35224 | .76686 | 1.30401 | .79496 | 1.25792 | .82385 | 1.21382 | 31 |
| 30 | .71329 | 1.40195 | .73996 | 1.35142 | .76733 | 1.30323 | .79544 | 1.25717 | .82434 | 1.21310 | 30 |
| 31 | .71373 | 1.40109 | .74041 | 1.35060 | .76779 | 1.30244 | .79591 | 1.25642 | .82483 | 1.21238 | 29 |
| 32 | .71417 | 1.40022 | .74086 | 1.34978 | .76825 | 1.30166 | .79639 | 1.25567 | .82531 | 1.21166 | 28 |
| 33 | .71461 | 1.39936 | .74131 | 1.34896 | .76871 | 1.30087 | .79686 | 1.25492 | .82580 | 1.21094 | 27 |
| 34 | .71505 | 1.39850 | .74176 | 1.34814 | .76918 | 1.30009 | .79734 | 1.25417 | .82629 | 1.21023 | 26 |
| 35 | .71549 | 1.39764 | .74221 | 1.34732 | .76964 | 1.29931 | .79781 | 1.25343 | .82678 | 1.20951 | 25 |
| 36 | .71593 | 1.39679 | .74267 | 1.34650 | .77010 | 1.29853 | .79829 | 1.25268 | .82727 | 1.20879 | 24 |
| 37 | .71637 | 1.39593 | .74312 | 1.34568 | .77057 | 1.29775 | .79877 | 1.25193 | .82776 | 1.20808 | 23 |
| 38 | .71681 | 1.39507 | .74357 | 1.34487 | .77103 | 1.29696 | .79924 | 1.25118 | .82825 | 1.20736 | 22 |
| 39 | .71725 | 1.39421 | .74402 | 1.34405 | .77149 | 1.29618 | .79972 | 1.25044 | .82874 | 1.20665 | 21 |
| 40 | .71769 | 1.39336 | .74447 | 1.34323 | .77196 | 1.29541 | .80020 | 1.24969 | .82923 | 1.20593 | 20 |
| 41 | .71813 | 1.39250 | .74492 | 1.34242 | .77242 | 1.29463 | .80067 | 1.24895 | .82972 | 1.20522 | 19 |
| 42 | .71857 | 1.39165 | .74538 | 1.34160 | .77289 | 1.29385 | .80115 | 1.24820 | .83022 | 1.20451 | 18 |
| 43 | .71901 | 1.39079 | .74583 | 1.34079 | .77335 | 1.29307 | .80163 | 1.24746 | .83071 | 1.20379 | 17 |
| 44 | .71946 | 1.38994 | .74628 | 1.33998 | .77382 | 1.29229 | .80211 | 1.24672 | .83120 | 1.20308 | 16 |
| 45 | .71990 | 1.38909 | .74674 | 1.33916 | .77428 | 1.29152 | .80258 | 1.24597 | .83169 | 1.20237 | 15 |
| 46 | .72034 | 1.38824 | .74719 | 1.33835 | .77475 | 1.29074 | .80306 | 1.24523 | .83218 | 1.20166 | 14 |
| 47 | .72078 | 1.38738 | .74764 | 1.33754 | .77521 | 1.28997 | .80354 | 1.24449 | .83268 | 1.20095 | 13 |
| 48 | .72122 | 1.38653 | .74810 | 1.33673 | .77568 | 1.28919 | .80402 | 1.24375 | .83317 | 1.20024 | 12 |
| 49 | .72167 | 1.38568 | .74855 | 1.33592 | .77615 | 1.28842 | .80450 | 1.24301 | .83366 | 1.19953 | 11 |
| 50 | .72211 | 1.38484 | .74900 | 1.33511 | .77661 | 1.28764 | .80498 | 1.24227 | .83415 | 1.19882 | 10 |
| 51 | .72255 | 1.38399 | .74946 | 1.33430 | .77708 | 1.28687 | .80546 | 1.24153 | .83465 | 1.19811 | 9 |
| 52 | .72299 | 1.38314 | .74991 | 1.33349 | .77754 | 1.28610 | .80594 | 1.24079 | .83514 | 1.19740 | 8 |
| 53 | .72344 | 1.38229 | .75037 | 1.33268 | .77801 | 1.28533 | .80642 | 1.24005 | .83564 | 1.19669 | 7 |
| 54 | .72388 | 1.38145 | .75082 | 1.33187 | .77848 | 1.28456 | .80690 | 1.23931 | .83613 | 1.19599 | 6 |
| 55 | .72432 | 1.38060 | .75128 | 1.33107 | .77895 | 1.28379 | .80738 | 1.23858 | .83662 | 1.19528 | 5 |
| 56 | .72477 | 1.37976 | .75173 | 1.33026 | .77941 | 1.28302 | .80786 | 1.23784 | .83712 | 1.19457 | 4 |
| 57 | .72521 | 1.37891 | .75219 | 1.32946 | .77988 | 1.28225 | .80834 | 1.23710 | .83761 | 1.19387 | 3 |
| 58 | .72565 | 1.37807 | .75264 | 1.32865 | .78035 | 1.28148 | .80882 | 1.23637 | .83811 | 1.19316 | 2 |
| 59 | .72610 | 1.37722 | .75310 | 1.32785 | .78082 | 1.28071 | .80930 | 1.23563 | .83860 | 1.19246 | 1 |
| 60 | .72654 | 1.37638 | .75355 | 1.32704 | .78129 | 1.27994 | .80978 | 1.23490 | .83910 | 1.19175 | 0 |
| ′ | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | ′ |
| | 54° | | 53° | | 52° | | 51° | | 50° | | |

| ′ | 40° | | 41° | | 42° | | 43° | | 44° | | ′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | |
| 0 | .83910 | 1.19175 | .86929 | 1.15037 | .90040 | 1.11061 | .93252 | 1.07237 | .96569 | 1.03553 | 60 |
| 1 | .83960 | 1.19105 | .86980 | 1.14969 | .90093 | 1.10996 | .93306 | 1.07174 | .96625 | 1.03493 | 59 |
| 2 | .84009 | 1.19035 | .87031 | 1.14902 | .90146 | 1.10931 | .93360 | 1.07112 | .96681 | 1.03433 | 58 |
| 3 | .84059 | 1.18964 | .87082 | 1.14834 | .90199 | 1.10867 | .93415 | 1.07049 | .96738 | 1.03372 | 57 |
| 4 | .84108 | 1.18894 | .87133 | 1.14767 | .90251 | 1.10802 | .93469 | 1.06987 | .96794 | 1.03312 | 56 |
| 5 | .84158 | 1.18824 | .87184 | 1.14699 | .90304 | 1.10737 | .93524 | 1.06925 | .96850 | 1.03252 | 55 |
| 6 | .84208 | 1.18754 | .87236 | 1.14632 | .90357 | 1.10672 | .93578 | 1.06862 | .96907 | 1.03192 | 54 |
| 7 | .84258 | 1.18684 | .87287 | 1.14565 | .90410 | 1.10607 | .93633 | 1.06800 | .96963 | 1.03132 | 53 |
| 8 | .84307 | 1.18614 | .87338 | 1.14498 | .90463 | 1.10543 | .93688 | 1.06738 | .97020 | 1.03072 | 52 |
| 9 | .84357 | 1.18544 | .87389 | 1.14430 | .90516 | 1.10478 | .93742 | 1.06676 | .97076 | 1.03012 | 51 |
| 10 | .84407 | 1.18474 | .87441 | 1.14363 | .90569 | 1.10414 | .93797 | 1.06613 | .97133 | 1.02952 | 50 |
| 11 | .84457 | 1.18404 | .87492 | 1.14296 | .90621 | 1.10349 | .93852 | 1.06551 | .97189 | 1.02892 | 49 |
| 12 | .84507 | 1.18334 | .87543 | 1.14229 | .90674 | 1.10285 | .93906 | 1.06489 | .97246 | 1.02832 | 48 |
| 13 | .84556 | 1.18264 | .87595 | 1.14162 | .90727 | 1.10220 | .93961 | 1.06427 | .97302 | 1.02772 | 47 |
| 14 | .84606 | 1.18194 | .87646 | 1.14095 | .90781 | 1.10156 | .94016 | 1.06365 | .97359 | 1.02713 | 46 |
| 15 | .84656 | 1.18125 | .87698 | 1.14028 | .90834 | 1.10091 | .94071 | 1.06303 | .97416 | 1.02653 | 45 |
| 16 | .84706 | 1.18055 | .87749 | 1.13961 | .90887 | 1.10027 | .94125 | 1.06241 | .97472 | 1.02593 | 44 |
| 17 | .84756 | 1.17986 | .87801 | 1.13894 | .90940 | 1.09963 | .94180 | 1.06179 | .97529 | 1.02533 | 43 |
| 18 | .84806 | 1.17916 | .87852 | 1.13828 | .90993 | 1.09899 | .94235 | 1.06117 | .97586 | 1.02474 | 42 |
| 19 | .84856 | 1.17846 | .87904 | 1.13761 | .91046 | 1.09834 | .94290 | 1.06056 | .97643 | 1.02414 | 41 |
| 20 | .84906 | 1.17777 | .87955 | 1.13694 | .91099 | 1.09770 | .94345 | 1.05994 | .97700 | 1.02355 | 40 |
| 21 | .84956 | 1.17708 | .88007 | 1.13627 | .91153 | 1.09706 | .94400 | 1.05932 | .97756 | 1.02295 | 39 |
| 22 | .85006 | 1.17638 | .88059 | 1.13561 | .91206 | 1.09642 | .94455 | 1.05870 | .97813 | 1.02236 | 38 |
| 23 | .85057 | 1.17569 | .88110 | 1.13494 | .91259 | 1.09578 | .94510 | 1.05809 | .97870 | 1.02176 | 37 |
| 24 | .85107 | 1.17500 | .88162 | 1.13428 | .91313 | 1.09514 | .94565 | 1.05747 | .97927 | 1.02117 | 36 |
| 25 | .85157 | 1.17430 | .88214 | 1.13361 | .91366 | 1.09450 | .94620 | 1.05685 | .97984 | 1.02057 | 35 |
| 26 | .85207 | 1.17361 | .88265 | 1.13295 | .91419 | 1.09386 | .94676 | 1.05624 | .98041 | 1.01998 | 34 |
| 27 | .85257 | 1.17292 | .88317 | 1.13228 | .91473 | 1.09322 | .94731 | 1.05562 | .98098 | 1.01939 | 33 |
| 28 | .85308 | 1.17223 | .88369 | 1.13162 | .91526 | 1.09258 | .94786 | 1.05501 | .98155 | 1.01879 | 32 |
| 29 | .85358 | 1.17154 | .88421 | 1.13096 | .91580 | 1.09195 | .94841 | 1.05439 | .98213 | 1.01820 | 31 |
| 30 | .85408 | 1.17085 | .88473 | 1.13029 | .91633 | 1.09131 | .94896 | 1.05378 | .98270 | 1.01761 | 30 |
| 31 | .85458 | 1.17016 | .88524 | 1.12963 | .91687 | 1.09067 | .94952 | 1.05317 | .98327 | 1.01702 | 29 |
| 32 | .85509 | 1.16947 | .88576 | 1.12897 | .91740 | 1.09003 | .95007 | 1.05255 | .98384 | 1.01642 | 28 |
| 33 | .85559 | 1.16878 | .88628 | 1.12831 | .91794 | 1.08940 | .95062 | 1.05194 | .98441 | 1.01583 | 27 |
| 34 | .85609 | 1.16809 | .88680 | 1.12765 | .91847 | 1.08876 | .95118 | 1.05133 | .98499 | 1.01524 | 26 |
| 35 | .85660 | 1.16741 | .88732 | 1.12699 | .91901 | 1.08813 | .95173 | 1.05072 | .98556 | 1.01465 | 25 |
| 36 | .85710 | 1.16672 | .88784 | 1.12633 | .91955 | 1.08749 | .95229 | 1.05010 | .98613 | 1.01406 | 24 |
| 37 | .85761 | 1.16603 | .88836 | 1.12567 | .92008 | 1.08686 | .95284 | 1.04949 | .98671 | 1.01347 | 23 |
| 38 | .85811 | 1.16535 | .88888 | 1.12501 | .92062 | 1.08622 | .95340 | 1.04888 | .98728 | 1.01288 | 22 |
| 39 | .85862 | 1.16466 | .88940 | 1.12435 | .92116 | 1.08559 | .95395 | 1.04827 | .98786 | 1.01229 | 21 |
| 40 | .85912 | 1.16398 | .88992 | 1.12369 | .92170 | 1.08496 | .95451 | 1.04766 | .98843 | 1.01170 | 20 |
| 41 | .85963 | 1.16329 | .89045 | 1.12303 | .92224 | 1.08432 | .95506 | 1.04705 | .98901 | 1.01112 | 19 |
| 42 | .86014 | 1.16261 | .89097 | 1.12238 | .92277 | 1.08369 | .95562 | 1.04644 | .98958 | 1.01053 | 18 |
| 43 | .86064 | 1.16192 | .89149 | 1.12172 | .92331 | 1.08306 | .95618 | 1.04583 | .99016 | 1.00994 | 17 |
| 44 | .86115 | 1.16124 | .89201 | 1.12106 | .92385 | 1.08243 | .95673 | 1.04522 | .99073 | 1.00935 | 16 |
| 45 | .86166 | 1.16056 | .89253 | 1.12041 | .92439 | 1.08179 | .95729 | 1.04461 | .99131 | 1.00876 | 15 |
| 46 | .86216 | 1.15987 | .89306 | 1.11975 | .92493 | 1.08116 | .95785 | 1.04401 | .99189 | 1.00818 | 14 |
| 47 | .86267 | 1.15919 | .89358 | 1.11909 | .92547 | 1.08053 | .95841 | 1.04340 | .99247 | 1.00759 | 13 |
| 48 | .86318 | 1.15851 | .89410 | 1.11844 | .92601 | 1.07990 | .95897 | 1.04279 | .99304 | 1.00701 | 12 |
| 49 | .86368 | 1.15783 | .89463 | 1.11778 | .92655 | 1.07927 | .95952 | 1.04218 | .99362 | 1.00642 | 11 |
| 50 | .86419 | 1.15715 | .89515 | 1.11713 | .92709 | 1.07864 | .96008 | 1.04158 | .99420 | 1.00583 | 10 |
| 51 | .86470 | 1.15647 | .89567 | 1.11648 | .92763 | 1.07801 | .96064 | 1.04097 | .99478 | 1.00525 | 9 |
| 52 | .86521 | 1.15579 | .89620 | 1.11582 | .92817 | 1.07738 | .96120 | 1.04036 | .99536 | 1.00467 | 8 |
| 53 | .86572 | 1.15511 | .89672 | 1.11517 | .92872 | 1.07676 | .96176 | 1.03976 | .99594 | 1.00408 | 7 |
| 54 | .86623 | 1.15443 | .89725 | 1.11452 | .92926 | 1.07613 | .96232 | 1.03915 | .99652 | 1.00350 | 6 |
| 55 | .86674 | 1.15375 | .89777 | 1.11387 | .92980 | 1.07550 | .96288 | 1.03855 | .99710 | 1.00291 | 5 |
| 56 | .86725 | 1.15308 | .89830 | 1.11321 | .93034 | 1.07487 | .96344 | 1.03794 | .99768 | 1.00233 | 4 |
| 57 | .86776 | 1.15240 | .89883 | 1.11256 | .93088 | 1.07425 | .96400 | 1.03734 | .99826 | 1.00175 | 3 |
| 58 | .86827 | 1.15172 | .89935 | 1.11191 | .93143 | 1.07362 | .96457 | 1.03674 | .99884 | 1.00116 | 2 |
| 59 | .86878 | 1.15104 | .89988 | 1.11126 | .93197 | 1.07299 | .96513 | 1.03613 | .99942 | 1.00058 | 1 |
| 60 | .86929 | 1.15037 | .90040 | 1.11061 | .93252 | 1.07237 | .96569 | 1.03553 | 1.00000 | 1.00000 | 0 |
| ′ | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | Cotang | Tang | ′ |
| | 49° | | 48° | | 47° | | 46° | | 45° | | |

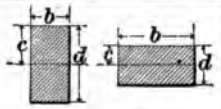
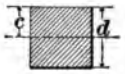
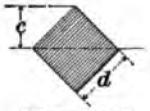
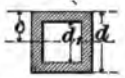
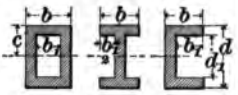
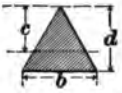
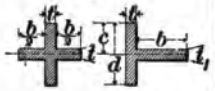
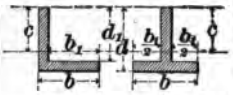
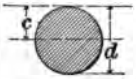
# THE PROPERTIES OF SATURATED STEAM.

| Pressure above Vacuum in Pounds per Square Inch. | Temperature, Fahrenheit Degrees. | Quantities of Heat in British Thermal Units. | | | Weight of a Cubic Foot of Steam in Pounds. | Volume. | |
|---|---|---|---|---|---|---|---|
| | | Required to Raise Temperature of the Water from 32° to $t$°. | Total Latent Heat at Pressure $P$. | Total Heat above 32°. | | Of a Pound of Steam in Cubic Feet. | Ratio of Vol. of Steam to Vol. of Eq. Weight of Dist. Water at Temp. of Maximum Density. |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| $p$ | $t$ | $q$ | $L$ | $H$ | $W$ | $V$ | $R$ |
| 1 | 102.018 | 70.040 | 1043.015 | 1113.055 | .003027 | 330.4 | 20623 |
| 2 | 126.302 | 94.368 | 1026.094 | 1120.462 | .005818 | 171.9 | 10730 |
| 3 | 141.654 | 109.764 | 1015.380 | 1125.144 | .008522 | 117.3 | 7325 |
| 4 | 153.122 | 121.271 | 1007.370 | 1128.641 | .011172 | 89.51 | 5588 |
| 5 | 162.370 | 130.563 | 1000.899 | 1131.462 | .013781 | 72.56 | 4530 |
| 6 | 170.173 | 138.401 | 995.441 | 1133.842 | .016357 | 61.14 | 3816 |
| 7 | 176.945 | 145.213 | 990.695 | 1135.908 | .018908 | 52.89 | 3302 |
| 8 | 182.952 | 151.255 | 986.485 | 1137.740 | .021436 | 46.65 | 2912 |
| 9 | 188.357 | 156.699 | 982.690 | 1139.389 | .023944 | 41.77 | 2607 |
| 10 | 193.284 | 161.660 | 979.232 | 1140.892 | .026437 | 37.83 | 2361 |
| 11 | 197.814 | 166.225 | 976.050 | 1142.275 | .028911 | 34.59 | 2159 |
| 12 | 202.012 | 170.457 | 973.098 | 1143.555 | .031376 | 31.87 | 1990 |
| 13 | 205.929 | 174.402 | 970.346 | 1144.748 | .033828 | 29.56 | 1845 |
| 14 | 209.604 | 178.112 | 967.757 | 1145.869 | .036265 | 27.58 | 1721 |
| 14.69 | 212.000 | 180.531 | 966.069 | 1146.600 | .037928 | 26.37 | 1646 |
| 15 | 213.067 | 181.608 | 965.318 | 1146.926 | .038688 | 25.85 | 1614 |
| 16 | 216.347 | 184.919 | 963.007 | 1147.926 | .041109 | 24.33 | 1519 |
| 17 | 219.452 | 188.056 | 960.818 | 1148.874 | .043519 | 22.98 | 1434 |
| 18 | 222.424 | 191.058 | 958.721 | 1149.779 | .045920 | 21.78 | 1359 |
| 19 | 225.255 | 193.918 | 956.725 | 1150.643 | .048312 | 20.70 | 1292 |

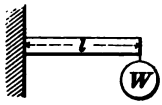
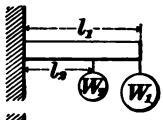
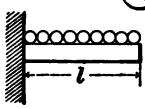
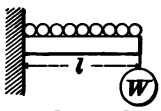
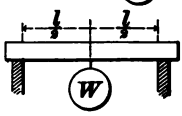
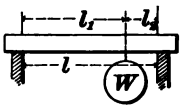
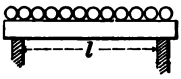
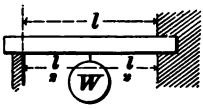
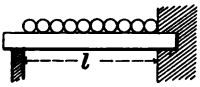
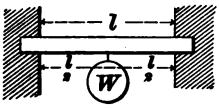
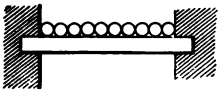
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| *p* | *t* | *q* | *L* | *H* | *W* | *V* | *R* |
| 20 | 227.964 | 196.655 | 954.814 | 1151.469 | .050696 | 19.73 | 1231.0 |
| 22 | 233.069 | 201.817 | 951.209 | 1153.026 | .055446 | 18.04 | 1126.0 |
| 24 | 237.803 | 206.610 | 947.861 | 1154.471 | .060171 | 16.62 | 1038.0 |
| 26 | 242.225 | 211.089 | 944.730 | 1155.819 | .064870 | 15.42 | 962.3 |
| 28 | 246.376 | 215.293 | 941.791 | 1157.084 | .069545 | 14.38 | 897.6 |
| 30 | 250.293 | 219.261 | 939.019 | 1158.280 | .074201 | 13.48 | 841.3 |
| 32 | 254.002 | 223.021 | 936.389 | 1159.410 | .078839 | 12.68 | 791.8 |
| 34 | 257.523 | 226.594 | 933.891 | 1160.485 | .083461 | 11.98 | 748.0 |
| 36 | 260.883 | 230.001 | 931.508 | 1161.509 | .088067 | 11.36 | 708.8 |
| 38 | 264.093 | 233.261 | 929.227 | 1162.488 | .092657 | 10.79 | 673.7 |
| 40 | 267.168 | 236.386 | 927.040 | 1163.426 | .097231 | 10.28 | 642.0 |
| 42 | 270.122 | 239.389 | 924.940 | 1164.329 | .101794 | 9.826 | 613.3 |
| 44 | 272.965 | 242.275 | 922.919 | 1165.194 | .106345 | 9.403 | 587.0 |
| 46 | 275.704 | 245.061 | 920.968 | 1166.029 | .110884 | 9.018 | 563.0 |
| 48 | 278.348 | 247.752 | 919.084 | 1166.836 | .115411 | 8.665 | 540.9 |
| 50 | 280.904 | 250.355 | 917.260 | 1167.615 | .119927 | 8.338 | 520.5 |
| 52 | 283.381 | 252.875 | 915.494 | 1168.369 | .124433 | 8.037 | 501.7 |
| 54 | 285.781 | 255.321 | 913.781 | 1169.102 | .128928 | 7.756 | 484.2 |
| 56 | 288.111 | 257.695 | 912.118 | 1169.813 | .133414 | 7.496 | 467.9 |
| 58 | 290.374 | 260.002 | 910.501 | 1170.503 | .137892 | 7.252 | 452.7 |
| 60 | 292.575 | 262.248 | 908.928 | 1171.176 | .142362 | 7.024 | 438.5 |
| 62 | 294.717 | 264.433 | 907.396 | 1171.829 | .146824 | 6.811 | 425.2 |
| 64 | 296.805 | 266.566 | 905.900 | 1172.466 | .151277 | 6.610 | 412.6 |
| 66 | 298.842 | 268.644 | 904.443 | 1173.087 | .155721 | 6.422 | 400.8 |
| 68 | 300.831 | 270.674 | 903.020 | 1173.694 | .160157 | 6.244 | 389.8 |
| 70 | 302.774 | 272.657 | 901.629 | 1174.286 | .164584 | 6.076 | 379.3 |
| 72 | 304.669 | 274.597 | 900.269 | 1174.866 | .169003 | 5.917 | 369.4 |
| 74 | 306.526 | 276.493 | 898.938 | 1175.431 | .173417 | 5.767 | 360.0 |
| 76 | 308.344 | 278.350 | 897.635 | 1175.985 | .177825 | 5.624 | 351.1 |
| 78 | 310.123 | 280.170 | 896.359 | 1176.529 | .182229 | 5.488 | 342.6 |
| 80 | 311.866 | 281.952 | 895.108 | 1177.060 | .186627 | 5.358 | 334.5 |
| 82 | 313.576 | 283.701 | 893.879 | 1177.580 | .191017 | 5.235 | 326.8 |
| 84 | 315.250 | 285.414 | 892.677 | 1178.091 | .195401 | 5.118 | 319.5 |
| 86 | 316.893 | 287.096 | 891.496 | 1178.592 | .199781 | 5.006 | 312.5 |
| 88 | 318.510 | 288.750 | 890.335 | 1179.085 | .204155 | 4.898 | 305.8 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| *p* | *t* | *q* | *L* | *H* | *W* | *V* | *R* |
| 90 | 320.094 | 290.373 | 889.196 | 1179.569 | .208525 | 4.796 | 299.4 |
| 92 | 321.653 | 291.970 | 888.075 | 1180.045 | .212892 | 4.697 | 293.2 |
| 94 | 323.183 | 293.539 | 886.972 | 1180.511 | .217253 | 4.603 | 287.3 |
| 96 | 324.688 | 295.083 | 885.887 | 1180.970 | .221604 | 4.513 | 281.7 |
| 98 | 326.169 | 296.601 | 884.821 | 1181.422 | .225950 | 4.426 | 276.3 |
| 100 | 327.625 | 298.093 | 883.773 | 1181.866 | .230293 | 4.342 | 271.1 |
| 105 | 331.169 | 301.731 | 881.214 | 1182.945 | .241139 | 4.147 | 258.9 |
| 110 | 334.582 | 305.242 | 878.744 | 1183.986 | .251947 | 3.969 | 247.8 |
| 115 | 337.874 | 308.621 | 876.371 | 1184.992 | .262732 | 3.806 | 237.6 |
| 120 | 341.058 | 311.885 | 874.076 | 1185.961 | .273500 | 3.656 | 228.3 |
| 125 | 344.136 | 315.051 | 871.848 | 1186.899 | .284243 | 3.518 | 219.6 |
| 130 | 347.121 | 318.121 | 869.688 | 1187.809 | .294961 | 3.390 | 211.6 |
| 135 | 350.015 | 321.105 | 867.590 | 1188.695 | .305659 | 3.272 | 204.2 |
| 140 | 352.827 | 324.003 | 865.552 | 1189.555 | .316338 | 3.161 | 197.3 |
| 145 | 355.562 | 326.823 | 863.567 | 1190.390 | .326998 | 3.058 | 190.9 |
| 150 | 358.223 | 329.566 | 861.634 | 1191.200 | .337643 | 2.962 | 184.9 |
| 160 | 363.346 | 334.850 | 857.912 | 1192.762 | .358886 | 2.786 | 173.9 |
| 170 | 368.226 | 339.892 | 854.359 | 1194.251 | .380071 | 2.631 | 164.3 |
| 180 | 372.886 | 344.708 | 850.963 | 1195.671 | .401201 | 2.493 | 155.6 |
| 190 | 377.352 | 349.329 | 847.703 | 1197.032 | .422280 | 2.368 | 147.8 |
| 200 | 381.636 | 353.766 | 844.573 | 1198.339 | .443310 | 2.256 | 140.8 |
| 210 | 385.759 | 358.041 | 841.556 | 1199.597 | .464295 | 2.154 | 134.5 |
| 220 | 389.736 | 362.168 | 838.642 | 1200.810 | .485237 | 2.061 | 128.7 |
| 230 | 393.575 | 366.152 | 835.828 | 1201.980 | .506139 | 1.976 | 123.3 |
| 240 | 397.285 | 370.008 | 833.103 | 1203.111 | .527003 | 1.898 | 118.5 |
| 250 | 400.883 | 373.750 | 830.459 | 1204.209 | .547831 | 1.825 | 114.0 |
| 260 | 404.370 | 377.377 | 827.896 | 1205.273 | .568626 | 1.759 | 109.8 |
| 270 | 407.755 | 380.905 | 825.401 | 1206.306 | .589390 | 1.697 | 105.9 |
| 280 | 411.048 | 384.337 | 822.973 | 1207.310 | .610124 | 1.639 | 102.3 |
| 290 | 414.250 | 387.677 | 820.609 | 1208.286 | .630829 | 1.585 | 99.0 |
| 300 | 417.371 | 390.933 | 818.305 | 1209.238 | .651506 | 1.535 | 95.8 |

# MOMENTS OF INERTIA.

| Form of Section. | Dotted Line Shows Position of Neutral Axis. | A | I | c |
|---|---|---|---|---|
| 1. Rectangle... |  | $bd$ | $\frac{1}{12}bd^3$ | $\frac{1}{2}d$ |
| 2. Square.. |  | $d^2$ | $\frac{1}{12}d^4$ | $\frac{1}{2}d$ |
| 3. Axis through Diagonal |  | $d^2$ | $\frac{1}{12}d^4$ | $.707d$ |
| 4. Hollow Square |  | $d^2-d_1^2$ | $\frac{1}{12}(d^4-d_1^4)$ | $\frac{1}{2}d$ |
| 5. Hollow Rectangle, I or Channel Iron |  | $bd-b_1d_1$ | $\frac{1}{12}(bd^3-b_1d_1^3)$ | $\frac{1}{2}d$ |
| 6. Triangle |  | $\frac{1}{2}bd$ | $\frac{1}{36}bd^3$ | $\frac{2}{3}d$ |
| 7. Cross.... |  | $td+t_1b$ | $\frac{1}{12}(td^3+bt_1^3)$ | $\frac{1}{2}d$ |
| 8. Angle Iron..... |  | $bd-b_1d_1$ | $\frac{(bd^2-b_1d_1^2)^2-4bdb_1d_1(d-d_1)^2}{12(bd-b_1d_1)}$ | $\frac{d}{2}+\frac{b_1d_1}{2}\left(\frac{d-d_1}{bd-b_1d_1}\right)$ |
| 9. Circle.... |  | $\frac{\pi}{4}d^2$ | $\frac{\pi d^4}{64}$ | $\frac{1}{2}d$ |
| 10. Hollow Circle... | | $\frac{\pi}{4}(d^2-d_1^2)$ | $\frac{\pi(d^4-d_1^4)}{64}$ | $\frac{1}{2}d$ |
| 11. Ellipse... | | $\frac{\pi}{4}bd$ | $\frac{\pi bd^3}{64}$ | $\frac{1}{2}d$ |
| 12. Hollow Ellipse.. | | $\frac{\pi}{4}(bd-b_1d_1)$ | $\frac{\pi(bd^3-b_1d_1^3)}{64}$ | $\frac{1}{2}d$ |

# BENDING MOMENTS AND DEFLECTIONS.

| Manner of Supporting Beams. | Maximum Bending Moment, $M$. | Maximum Deflection, $s$. | Remarks. |
|---|---|---|---|
| 1.  | $Wl$ | $\frac{1}{3}\frac{Wl^3}{EI}$ | Cantilever, load at free end. |
| 2.  | $W_1l_1+W_2l_2$ | | Cantilever, more than one load. |
| 3.  | $\frac{wl^2}{2}$ | $\frac{1}{8}\frac{W'l^3}{EI}$ | Cantilever, uniform load $w$ lb. per unit of length. $W'=wl$. |
| 4.  | $\frac{wl^2}{2}+Wl$ | $\frac{1}{3}\frac{Wl^3}{EI}+\frac{1}{8}\frac{W'l^3}{EI}$ | Cantilever, load partly uniform, partly concentrated. |
| 5.  | $\frac{Wl}{4}$ | $\frac{1}{48}\frac{Wl^3}{EI}$ | Simple beam, load at middle. |
| 6.  | $W\frac{l_1l_2}{l}$ | | Simple beam, load at some other point than the middle. |
| 7.  | $\frac{wl^2}{8}$ | $\frac{5}{384}\frac{W'l^3}{EI}$ | Simple beam, uniformly loaded. |
| 8.  | $\frac{3}{16}Wl$ | $.0182\frac{Wl^3}{EI}$ | One end fixed, other end supported, load in the middle. |
| 9.  | $\frac{wl^2}{8}$ | $.0054\frac{W'l^3}{EI}$ | One end fixed, other end supported, uniformly loaded. |
| 10.  | $\frac{Wl}{8}$ | $\frac{1}{192}\frac{Wl^3}{EI}$ | Both ends fixed, load in the middle. |
| 11.  | $\frac{wl^2}{12}$ | $\frac{1}{384}\frac{W'l^3}{EI}$ | Both ends fixed, uniformly loaded. |

# SPECIFIC GRAVITIES AND WEIGHTS PER CUBIC FOOT.

## METALS.

| Substance. | Specific Gravity. | Weight per Cubic Foot in Pounds. |
|---|---|---|
| Osmium | 23.00 | 1,437.5 |
| Platinum | 21.50 | 1,343.8 |
| Gold | 19.50 | 1,218.8 |
| Mercury | 13.60 | 850.0 |
| Lead (cast) | 11.35 | 709.4 |
| Silver | 10.50 | 656.3 |
| Copper (cast) | 8.79 | 549.4 |
| Brass | 8.38 | 523.8 |
| Wrought Iron | 7.68 | 480.0 |
| Cast Iron | 7.21 | 450.0 |
| Steel | 7.84 | 490.0 |
| Tin (cast) | 7.29 | 455.6 |
| Zinc (cast) | 6.86 | 428.8 |
| Antimony | 6.71 | 419.4 |
| Aluminum | 2.50 | 156.3 |

## WOODS.

| Substance. | Specific Gravity. | Weight per Cubic Foot in Pounds. |
|---|---|---|
| Ash | .845 | 52.80 |
| Beech | .852 | 53.25 |
| Cedar | .561 | 35.06 |
| Cork | .240 | 15.00 |
| Ebony (American) | 1.331 | 83.19 |
| Lignum-vitæ | 1.333 | 83.30 |
| Maple | .750 | 46.88 |
| Oak (old) | 1.170 | 73.10 |
| Spruce | .500 | 31.25 |
| Pine (yellow) | .660 | 41.20 |
| Pine (white) | .554 | 34.60 |
| Walnut | .671 | 41.90 |

## LIQUIDS.

| Substance. | Specific Gravity. | Weight per Cubic Foot in Pounds. |
|---|---|---|
| Acetic Acid | 1.062 | 66.4 |
| Nitric Acid | 1.217 | 76.1 |
| Sulphuric Acid | 1.841 | 115.1 |
| Muriatic Acid | 1.200 | 75.0 |
| Alcohol | .800 | 50.0 |
| Turpentine | .870 | 54.4 |
| Sea Water (ordinary) | 1.026 | 64.1 |
| Milk | 1.032 | 64.5 |

## GASES.

At 32° F., and under a Pressure of One Atmosphere.

| Substance. | Specific Gravity. | Weight per Cubic Foot in Pounds. |
|---|---|---|
| Atmospheric Air | 1.0000 | .08073 |
| Carbonic Acid | 1.5290 | .12344 |
| Carbonic Oxide | .9674 | .07810 |
| Chlorine | 2.4400 | .19700 |
| Oxygen | 1.1056 | .08925 |
| Nitrogen | .9736 | .07860 |
| Smoke (bituminous coal) | .1020 | .00815 |
| Smoke (wood) | .0900 | .00727 |
| *Steam at 212° F. | .4700 | .03790 |
| Hydrogen | .0692 | .00559 |

* The specific gravity of steam at any temperature and pressure compared with air at the same temperature and pressure is 0.622.

### MISCELLANEOUS.

| Substance. | Specific Gravity. | Weight per Cubic Foot in Pounds. |
|---|---|---|
| Emery | 4.00 | 250 |
| Glass (average) | 2.80 | 175 |
| Chalk | 2.78 | 174 |
| Granite | 2.65 | 166 |
| Marble | 2.70 | 169 |
| Stone (common) | 2.52 | 158 |
| Salt (common) | 2.13 | 133 |
| Soil (common) | 1.98 | 124 |
| Clay | 1.93 | 121 |
| Brick | 1.90 | 118 |
| Plaster Paris (average) | 2.00 | 125 |
| Sand | 1.80 | 113 |

## MISCELLANEOUS TABLES.

### SPECIFIC HEATS UNDER CONSTANT PRESSURE.

#### SOLIDS.

| | | | |
|---|---|---|---|
| Copper | 0.0951 | Cast Iron | 0.1298 |
| Gold | 0.0324 | Lead | 0.0314 |
| Wrought Iron | 0.1138 | Platinum | 0.0324 |
| Steel (soft) | 0.1165 | Silver | 0.0570 |
| Steel (hard) | 0.1175 | Tin | 0.0562 |
| Zinc | 0.0956 | Ice | 0.5040 |
| Brass | 0.0939 | Sulphur | 0.2026 |
| Glass | 0.1937 | Charcoal | 0.2410 |

### LIQUIDS.

| | | | |
|---|---|---|---|
| Water | 1.0000 | Lead (melted) | 0.0402 |
| Alcohol | 0.7000 | Sulphur (melted) | 0.2340 |
| Mercury | 0.0333 | Tin (melted) | 0.0637 |
| Benzine | 0.4500 | Sulphuric Acid | 0.3350 |
| Glycerine | 0.5550 | Oil of Turpentine | 0.4260 |

### GASES.

| | Constant Pressure. | Constant Volume. |
|---|---|---|
| Air | 0.23751 | 0.16847 |
| Oxygen | 0.21751 | 0.15507 |
| Nitrogen | 0.24380 | 0.17273 |
| Hydrogen | 3.40900 | 2.41226 |
| Superheated Steam | 0.48050 | 0.34600 |
| Carbonic Oxide | 0.24790 | 0.17580 |
| Carbonic Acid | 0.40400 | 0.15350 |

### VOLUMES AND WEIGHTS OF GASES.

| Gas. | Volume of one Pound at 32°F. and a Tension of 1 Atmosphere (14.7 Lb. per Sq. In.). Cu. Ft. | Weight of one Cu. Ft. at 32° F. and a Tension of 1 Atmosphere (14.7 Lb. per Sq. In.). Lb. | R. |
|---|---|---|---|
| Air | 12.388 | .08073 | .37052 |
| Oxygen | 11.2056 | .08925 | .33552 |
| Nitrogen | 12.7226 | .0786 | .38143 |
| Hydrogen | 178.891 | .00559 | 5.34946 |

## TEMPERATURES OF FUSION AND VAPORIZATION.

| Substance. | Temperature of Fusion. | Temperature of Vaporization. | Latent Heat of Fusion. | Latent Heat of Vaporization. |
|---|---|---|---|---|
| Water | 32° | 212° | 142.65 | 966.6 |
| Mercury | − 37.8° | 662° | 5.09 | 157 |
| Sulphur | 228.3° | 824° | 13.26 | |
| Tin | 446° | | 25.65 | |
| Lead | 626° | | 9.67 | |
| Zinc | 680° | 1900° | 50.63 | 493 |
| Alcohol | Unknown | 173° | | 372 |
| Oil of Turpentine | 14° | 313° | | 124 |
| Linseed Oil | | 600° | | |
| Aluminum | 1400° | | | |
| Copper | 2100° | | | |
| Cast Iron | 2192° | 3300° | | |
| Wrought Iron | 2912° | 5000° | | |
| Steel | 2520° | | | |
| Platinum | 3632° | | | |
| Iridium | 4892° | | | |

## COEFFICIENTS OF EXPANSION.

| Name of Substance. | Linear Expansion. | Surface Expansion. | Cubic Expansion. |
|---|---|---|---|
| Cast Iron | .00000617 | .00001234 | .00001850 |
| Copper | .00000955 | .00001910 | .00002864 |
| Brass | .00001037 | .00002074 | .00003112 |
| Silver | .00000690 | .00001390 | .00002070 |
| Bar Iron | .00000686 | .00001372 | .00002058 |
| Steel (untempered) | .00000599 | .00001198 | .00001798 |
| Steel (tempered) | .00000702 | .00001404 | .00002106 |
| Zinc | .00001634 | .00003268 | .00004903 |
| Tin | .00001410 | .00002820 | .00004229 |
| Mercury | .00003334 | .00006668 | .00010010 |
| Alcohol | .00019259 | .00038518 | .00057778 |
| Gases | | | .00203252 |

## UNITED STATES STANDARD SCREW THREADS.

| Diameter of Screw in Inches. $d$ | Number of Threads per Inch. $n$ | Diameter at Bottom of Threads in Inches. $d_1$ | Area at Bottom of Threads in Square Inches. $a$ |
|---|---|---|---|
| $\frac{1}{4}$ | 20 | .185 | .0269 |
| $\frac{5}{16}$ | 18 | .240 | .0452 |
| $\frac{3}{8}$ | 16 | .294 | .0679 |
| $\frac{7}{16}$ | 14 | .345 | .0935 |
| $\frac{1}{2}$ | 13 | .400 | .1257 |
| $\frac{9}{16}$ | 12 | .454 | .1619 |
| $\frac{5}{8}$ | 11 | .507 | .2019 |
| $\frac{3}{4}$ | 10 | .620 | .3019 |
| $\frac{7}{8}$ | 9 | .731 | .4197 |
| 1 | 8 | .838 | .5515 |
| $1\frac{1}{8}$ | 7 | .939 | .6925 |
| $1\frac{1}{4}$ | 7 | 1.064 | .8892 |
| $1\frac{3}{8}$ | 6 | 1.158 | 1.0532 |
| $1\frac{1}{2}$ | 6 | 1.283 | 1.2928 |
| $1\frac{5}{8}$ | $5\frac{1}{2}$ | 1.389 | 1.5153 |
| $1\frac{3}{4}$ | 5 | 1.490 | 1.7437 |
| $1\frac{7}{8}$ | 5 | 1.615 | 2.0485 |
| 2 | $4\frac{1}{2}$ | 1.711 | 2.2993 |
| $2\frac{1}{4}$ | $4\frac{1}{2}$ | 1.961 | 3.0203 |
| $2\frac{1}{2}$ | 4 | 2.175 | 3.7154 |
| $2\frac{3}{4}$ | 4 | 2.425 | 4.6186 |
| 3 | $3\frac{1}{2}$ | 2.629 | 5.4284 |
| $3\frac{1}{4}$ | $3\frac{1}{2}$ | 2.879 | 6.5099 |
| $3\frac{1}{2}$ | $3\frac{1}{4}$ | 3.100 | 7.5477 |
| $3\frac{3}{4}$ | 3 | 3.317 | 8.6414 |
| 4 | 3 | 3.567 | 9.9930 |
| $4\frac{1}{4}$ | $2\frac{7}{8}$ | 3.798 | 11.3292 |
| $4\frac{1}{2}$ | $2\frac{3}{4}$ | 4.027 | 12.7366 |
| $4\frac{3}{4}$ | $2\frac{5}{8}$ | 4.255 | 14.2197 |
| 5 | $2\frac{1}{2}$ | 4.480 | 15.7633 |
| $5\frac{1}{4}$ | $2\frac{1}{2}$ | 4.730 | 17.5717 |
| $5\frac{1}{2}$ | $2\frac{3}{8}$ | 4.953 | 19.2676 |
| $5\frac{3}{4}$ | $2\frac{3}{8}$ | 5.203 | 21.2617 |
| 6 | $2\frac{1}{4}$ | 5.423 | 23.0978 |

## STANDARD DIMENSIONS OF WROUGHT-IRON STEAM, GAS, AND WATER PIPES.

| Nominal Diameter in Inches. | Thickness in Inches. | Actual Internal Diameter in Inches. | Actual External Diameter in Inches. | Threads per Inch. $n$ | Pitch of Threads. |
|---|---|---|---|---|---|
| $\frac{1}{8}$ | .068 | .270 | .405 | 27 | .037 |
| $\frac{1}{4}$ | .088 | .364 | .540 | 18 | .056 |
| $\frac{3}{8}$ | .091 | .494 | .675 | 18 | .056 |
| $\frac{1}{2}$ | .109 | .623 | .840 | 14 | .071 |
| $\frac{3}{4}$ | .113 | .824 | 1.050 | 14 | .071 |
| 1 | .134 | 1.048 | 1.315 | $11\frac{1}{2}$ | .087 |
| $1\frac{1}{4}$ | .140 | 1.380 | 1.660 | $11\frac{1}{2}$ | .087 |
| $1\frac{1}{2}$ | .145 | 1.611 | 1.900 | $11\frac{1}{2}$ | .087 |
| 2 | .154 | 2.067 | 2.375 | $11\frac{1}{2}$ | .087 |
| $2\frac{1}{2}$ | .204 | 2.468 | 2.875 | 8 | .125 |
| 3 | .217 | 3.061 | 3.500 | 8 | .125 |
| $3\frac{1}{2}$ | .226 | 3.548 | 4.000 | 8 | .125 |
| 4 | .237 | 4.026 | 4.500 | 8 | .125 |
| $4\frac{1}{2}$ | .247 | 4.508 | 5.000 | 8 | .125 |
| 5 | .259 | 5.045 | 5.563 | 8 | .125 |
| 6 | .280 | 6.065 | 6.625 | 8 | .125 |
| 7 | .301 | 7.023 | 7.625 | 8 | .125 |
| 8 | .322 | 7.982 | 8.625 | 8 | .125 |
| 9 | .344 | 9.001 | 9.688 | 8 | .125 |
| 10 | .366 | 10.019 | 10.750 | 8 | .125 |

## STANDARD PIPE FLANGES.

| Inside Diam. of Pipe. | Thickness of Pipe. | Diam. of Bolts. | Length of Bolts. | No. of Bolts. | Thickness of Flange. | Diam. of Bolt Circle. | Diam. of Flange. |
|---|---|---|---|---|---|---|---|
| 2.0 | .409 | $\frac{5}{8}$ | 2.0 | 4 | $\frac{5}{8}$ | 4.75 | 6.0 |
| 2.5 | .429 | $\frac{5}{8}$ | 2.25 | 4 | $\frac{11}{16}$ | 5.25 | 7.0 |
| 3.0 | .448 | $\frac{5}{8}$ | 2.5 | 4 | $\frac{3}{4}$ | 6.0 | 7.5 |
| 3.5 | .466 | $\frac{5}{8}$ | 2.5 | 4 | $\frac{13}{16}$ | 6.5 | 8.5 |
| 4.0 | .486 | $\frac{3}{4}$ | 2.75 | 4 | $\frac{15}{16}$ | 7.25 | 9.0 |
| 4.5 | .498 | $\frac{3}{4}$ | 3.0 | 8 | $\frac{15}{16}$ | 7.75 | 9.25 |
| 5 | .525 | $\frac{3}{4}$ | 3.0 | 8 | $\frac{15}{16}$ | 8.5 | 10.0 |
| 6 | .563 | $\frac{3}{4}$ | 3.0 | 8 | 1 | 9.625 | 11.0 |
| 7 | .600 | $\frac{3}{4}$ | 3.25 | 8 | $1\frac{1}{16}$ | 10.75 | 12.5 |
| 8 | .639 | $\frac{3}{4}$ | 3.5 | 8 | $1\frac{1}{8}$ | 11.75 | 13.5 |
| 9 | .678 | $\frac{3}{4}$ | 3.5 | 12 | $1\frac{1}{8}$ | 13.0 | 15.0 |
| 10 | .713 | $\frac{7}{8}$ | 3.625 | 12 | $1\frac{3}{16}$ | 14.25 | 16.0 |
| 12 | .790 | $\frac{7}{8}$ | 3.75 | 12 | $1\frac{1}{4}$ | 16.5 | 19.0 |
| 14 | .864 | 1 | 4.25 | 12 | $1\frac{3}{8}$ | 18.75 | 21.0 |
| 15 | .904 | 1 | 4.25 | 16 | $1\frac{3}{8}$ | 20.0 | 22.25 |
| 16 | .946 | 1 | 4.25 | 16 | $1\frac{7}{16}$ | 21.25 | 23.5 |
| 18 | 1.020 | $1\frac{1}{8}$ | 4.75 | 16 | $1\frac{9}{16}$ | 22.75 | 25.0 |
| 20 | 1.090 | $1\frac{1}{8}$ | 5.0 | 20 | $1\frac{11}{16}$ | 25.0 | 27.5 |
| 22 | 1.180 | $1\frac{1}{4}$ | 5.5 | 20 | $1\frac{13}{16}$ | 27.25 | 29.5 |
| 24 | 1.250 | $1\frac{1}{4}$ | 5.5 | 20 | $1\frac{7}{8}$ | 29.5 | 32.0 |
| 26 | 1.300 | $1\frac{1}{4}$ | 5.75 | 24 | 2 | 31.75 | 34.25 |
| 28 | 1.380 | $1\frac{1}{4}$ | 6.0 | 28 | $2\frac{1}{16}$ | 34.0 | 36.5 |
| 30 | 1.480 | $1\frac{3}{8}$ | 6.25 | 28 | $2\frac{1}{8}$ | 36.0 | 38.75 |
| 36 | 1.710 | $1\frac{3}{8}$ | 6.5 | 32 | $2\frac{3}{8}$ | 42.75 | 45.75 |
| 42 | 1.870 | $1\frac{1}{2}$ | 7.25 | 36 | $2\frac{5}{8}$ | 49.5 | 52.75 |
| 48 | 2.170 | $1\frac{1}{2}$ | 7.75 | 44 | $2\frac{3}{4}$ | 56.0 | 59.5 |

## LAP-WELDED AMERICAN CHARCOAL IRON BOILER TUBES.

### STANDARD DIMENSIONS.

| External Diameter. | Standard Thickness. | Wire Gauge. | Internal Diameter. | Internal Circumference. | External Circumference. | Length of Tube per sq. ft. Inside Surface. | Length of Tube per sq. ft. Out. Surface. | Internal Area. | External Area. | Weight per foot. |
|---|---|---|---|---|---|---|---|---|---|---|
| In. | In. | | In. | In. | In. | Ft. | Ft. | Sq. In. | Sq. In. | Lb. |
| 1 | .072 | 15 | .856 | 2.689 | 3.142 | 4.463 | 3.819 | .575 | .785 | .708 |
| 1½ | .083 | 14 | 1.334 | 4.191 | 4.712 | 2.863 | 2.547 | 1.396 | 1.767 | 1.250 |
| 2 | .098 | 13 | 1.804 | 5.667 | 6.283 | 2.118 | 1.909 | 2.556 | 3.142 | 1.981 |
| 2½ | .109 | 12 | 2.283 | 7.172 | 7.854 | 1.673 | 1.528 | 4.094 | 4.909 | 2.755 |
| 3 | .109 | 12 | 2.783 | 8.743 | 9.425 | 1.373 | 1.273 | 6.083 | 7.069 | 3.333 |
| 3½ | .119 | 11 | 3.262 | 10.248 | 10.996 | 1.171 | 1.091 | 8.357 | 9.621 | 4.272 |
| 4 | .130 | 10 | 3.741 | 11.753 | 12.566 | 1.021 | .955 | 10.992 | 12.566 | 5.320 |
| 4½ | .130 | 10 | 4.241 | 13.323 | 14.137 | .901 | .849 | 14.126 | 15.904 | 6.010 |
| 5 | .140 | 9.5 | 4.720 | 14.828 | 15.708 | .809 | .764 | 17.497 | 19.635 | 7.276 |
| 6 | .151 | 9 | 5.699 | 17.904 | 18.850 | .670 | .637 | 25.509 | 28.274 | 9.346 |

## PROPORTIONS OF RIVETED JOINTS.

| Thickness of Plate. $t$ | Diameter of Rivet. | Diameter of Hole. $d$ | Pitch. | | Efficiency of Joint. | |
|---|---|---|---|---|---|---|
| | | | Single. | Double. | Single. | Double. |
| $\frac{1}{4}''$ | $\frac{5}{8}''$ | $\frac{11}{16}''$ | $2''$ | $3''$ | .66 | .77 |
| $\frac{5}{16}''$ | $\frac{11}{16}''$ | $\frac{3}{4}''$ | $2\frac{1}{16}''$ | $3\frac{1}{8}''$ | .64 | .76 |
| $\frac{3}{8}''$ | $\frac{3}{4}''$ | $\frac{13}{16}''$ | $2\frac{1}{8}''$ | $3\frac{1}{4}''$ | .62 | .75 |
| $\frac{7}{16}''$ | $\frac{13}{16}''$ | $\frac{7}{8}''$ | $2\frac{3}{16}''$ | $3\frac{3}{8}''$ | .60 | .74 |
| $\frac{1}{2}''$ | $\frac{7}{8}''$ | $\frac{15}{16}''$ | $2\frac{1}{4}''$ | $3\frac{1}{2}''$ | .58 | .73 |

## PROPORTIONS OF GEAR TEETH.

$C$ = Circular Pitch.

| | Rough Cast Gears. | Cut Gears. |
|---|---|---|
| Addendum | 0.30 $C$ | 0.30 $C$ |
| Root | 0.40 $C$ | 0.35 $C$ |
| Whole Depth | 0.70 $C$ | 0.65 $C$ |
| Thickness of Tooth | 0.48 $C$ | 0.495 $C$ |
| Width of Space | 0.52 $C$ | 0.505 $C$ |

## RELATION BETWEEN DIAMETRAL AND CIRCULAR PITCH.

| Diametral Pitch. | Circular Pitch. | Circular Pitch. | Diametral Pitch. |
|---|---|---|---|
| 2 | 1.571 inches. | 2 inches | 1.571 |
| $2\frac{1}{4}$ | 1.396 " | $1\frac{7}{8}$ " | 1.676 |
| $2\frac{1}{2}$ | 1.257 " | $1\frac{3}{4}$ " | 1.795 |
| $2\frac{3}{4}$ | 1.142 " | $1\frac{5}{8}$ " | 1.933 |
| 3 | 1.047 " | $1\frac{1}{2}$ " | 2.094 |
| $3\frac{1}{2}$ | .898 " | $1\frac{7}{16}$ " | 2.185 |
| 4 | .785 " | $1\frac{3}{8}$ " | 2.285 |
| 5 | .628 " | $1\frac{5}{16}$ " | 2.394 |
| 6 | .524 " | $1\frac{1}{4}$ " | 2.513 |
| 7 | .449 " | $1\frac{3}{16}$ " | 2.646 |
| 8 | .393 " | $1\frac{1}{8}$ " | 2.793 |
| 9 | .349 " | $1\frac{1}{16}$ " | 2.957 |
| 10 | .314 " | 1 | 3.142 |
| 11 | .286 " | $\frac{15}{16}$ " | 3.351 |
| 12 | .262 " | $\frac{7}{8}$ " | 3.590 |
| 14 | .224 " | $\frac{13}{16}$ " | 3.867 |
| 16 | .196 " | $\frac{3}{4}$ " | 4.189 |
| 18 | .175 " | $\frac{11}{16}$ " | 4.570 |
| 20 | .157 " | $\frac{5}{8}$ " | 5.027 |

## BREAKING STRENGTH OF AND POWER TRANSMITTED BY WIRE ROPES (42 WIRES).

| Diameter of Ropes, Inches. | Diameter of Pulleys, Feet. | Revolutions per Minute. | Breaking Stress of Rope per Pound. | Horse-power Transmitted. | Velocity of Rope in Feet per Second. |
|---|---|---|---|---|---|
| $\frac{7}{16}$ | 5 | 100 | 4,260 | 8.6 | 26 |
| $\frac{15}{32}$ | 6 | 100 | 5,660 | 13.4 | 31 |
| $\frac{1}{2}$ | 7 | 100 | 8,200 | 21.1 | 36 |
| $\frac{5}{8}$ | 8 | 100 | 11,600 | 27.5 | 42 |
| $\frac{5}{8}$ | 8 | 120 | 11,600 | 33.0 | 50 |
| $\frac{5}{8}$ | 9 | 100 | 11,600 | 51.9 | 47 |
| $\frac{5}{8}$ | 9 | 120 | 11,600 | 62.2 | 56 |
| $\frac{11}{16}$ | 10 | 100 | 15,200 | 73.0 | 52 |
| $\frac{11}{16}$ | 10 | 120 | 15,200 | 87.6 | 62 |
| $\frac{11}{16}$ | 10 | 140 | 15,200 | 102.2 | 73 |
| $\frac{11}{16}$ | 12 | 100 | 15,200 | 116.7 | 63 |
| $\frac{3}{4}$ | 12 | 120 | 17,600 | 148.9 | 75 |
| $\frac{3}{4}$ | 12 | 140 | 17,600 | 173.7 | 87 |
| $\frac{3}{4}$ | 14 | 100 | 17,600 | 185.0 | 73 |
| $\frac{3}{4}$ | 14 | 120 | 17,600 | 222.0 | 87 |
| $\frac{3}{4}$ | 15 | 120 | 17,600 | 300.0 | 94 |

## SAFE PRESSURE ON BEARINGS AND SLIDES

| Kind of Journal Bearing. | Pressure per Sq. In. of Projected Area, $p$. |
|---|---|
| Bearings on which the load is intermittent and the speed slow, such as crank-pins of shearing machines | 3,000 lb. |
| Cross-head neck journals | 1,200 lb. |
| Crank-pins of large, slow-speed engines....800 to | 900 lb. |
| Crank-pins of marine engines, usually.....400 to | 500 lb. |
| Main crank-shaft bearings—marine engines (slow) | 600 lb. |

| | |
|---|---|
| Main crank-shaft bearings—marine engines (fast) | 400 lb. |
| Locomotive driving-axle journal..... | 180 to 350 lb |
| Railway journals..... | 200 lb. |
| Fly-wheel shaft journals..... | 150 to 250 lb. |
| Small engine crank-pins..... | 150 to 200 lb. |
| Slipper slide blocks, marine engines..... | 100 lb. |
| Stationary engine slide blocks..... | 25 to 125 lb. |
| Stationary engine slide blocks, usually..... | 30 to 60 lb. |
| Propeller thrust bearings..... | 50 to 70 lb. |
| Shaft in cast-iron steps or seats..... | 15 lb. |

# RULES AND FORMULAS.

## FORMULAS USED IN ALGEBRA.

Let $a$ and $b$ be any two quantities, then,

$$(a+b)^2 = a^2 + 2ab + b^2. \quad (1.) \text{ Art. } \mathbf{432.}$$

$$(a-b)^2 = a^2 - 2ab + b^2. \quad (2.) \text{ Art. } \mathbf{432.}$$

$$(a+b)(a-b) = a^2 - b^2. \quad (3.) \text{ Art. } \mathbf{432.}$$

$$a^2+2ab+b^2=(a+b)(a+b)=(a+b)^2. \quad (4.) \text{ Art. } \mathbf{455.}$$

$$a^2-2ab+b^2=(a-b)(a-b)=(a-b)^2. \quad (5.) \text{ Art. } \mathbf{455.}$$

$$a^2 - b^2 = (a+b)(a-b). \quad (6.) \text{ Art. } \mathbf{462.}$$

Let $ax^2 + bx = c$ be any quadratic equation (it must be borne in mind that $b$ and $c$ may be positive or negative); then,

$$x = -\frac{b}{2a} \pm \sqrt{\left(\frac{b}{2a}\right)^2 + \frac{c}{a}} = \frac{-b \pm \sqrt{b^2 + 4ac}}{2a}. \quad \text{Art. } \mathbf{597}$$

## THE TRIGONOMETRIC FUNCTIONS.

Art. **754.**

**Rule 1.**—*Sine* $= \dfrac{\textit{side opposite}}{\textit{hypotenuse}}$.

**Rule 2.**—*Side opposite = hypotenuse × sine.*

**Rule 3.**—*Cosine* $= \dfrac{\textit{side adjacent}}{\textit{hypotenuse}}$.

**Rule 4.**—*Side adjacent = hypotenuse × cosine.*

**Rule 5.**—*Tangent* $= \frac{\textit{side opposite}}{\textit{side adjacent}}$.

**Rule 6.**—*Side opposite = side adjacent* × ***tangent.***

**Rule 7.**—*Cotangent* $= \frac{\textit{side adjacent}}{\textit{side opposite}}$.

**Rule 8.**—*Side adjacent = side opposite* × ***cotangent.***

**Rule 9.**—*Hypotenuse* $= \frac{\textit{side opposite}}{\textit{sine}}$.

**Rule 10.**—*Hypotenuse* $= \frac{\textit{side adjacent}}{\textit{cosine}}$.

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## RULES FOR USING TABLE OF LOGARITHMS OF NUMBERS.

Arts. **625–636.**

I. **To find the Characteristic.**—*For a number greater than 1 the characteristic is one less than the number of integral places in the number. For a number wholly decimal the characteristic is negative, and is numerically one greater than the number of ciphers between the decimal point and the first digit of the decimal.*

II. **To find the Logarithm of a Number not having more than four figures.**—*Find the first three significant figures of the number whose logarithm is desired in the left-hand column; find the fourth figure in the column at the top (or bottom) of the page, and in the column under (or above) this figure, and opposite the first three figures previously found, will be the mantissa, or decimal part, of the logarithm. The characteristic being found as described above, write it at the left of the mantissa, and the resulting expression will be the logarithm of the required number.*

III. **To find the Logarithm of a Number consisting of five or more figures.**

(*a*) *If the number consists of more than five figures, and the sixth figure is 5 or greater, increase the fifth figure by 1, and write ciphers in place of the sixth and remaining figures.*

(**b**) *Find the mantissa corresponding to the logarithm of the first four figures, and subtract this mantissa from the next greater mantissa in the table; the remainder is the difference.*

(**c**) *Find in the secondary table headed P. P. a column headed by the same number as that just found for the difference, and in this column opposite the number corresponding to the fifth figure (or fifth figure increased by 1) of the given number (this figure is always situated at the left of the dividing line of the column) will be found the P. P. (proportional part) for that number. The P. P. thus found is to be added to the mantissa found in* (**b**), *and the result is the mantissa of the logarithm of the given number, as nearly as may be found with five-place tables.*

IV. **To find a Number whose Logarithm is given.—**

(**a**) *Consider the mantissa first. Glance along the different columns of the table which are headed O until the first two figures of the mantissa are found. Then glance down the same column until the third figure is found (or 1 less than the third figure). Having found the first three figures, glance to the right along the row in which they are situated until the last three figures of the mantissa are found. Then the number which heads the column in which the last three figures of the mantissa are found is the fourth figure of the required number, and the first three figures lie in the column headed N, and in the same row in which lie the last three figures of the mantissa.*

(**b**) *If the mantissa cannot be found in the table, find the mantissa which is nearest to, but less than, the given mantissa, and which call the* **next less mantissa.** *Subtract the next less mantissa from the next greater mantissa in the table to obtain the difference. Also subtract the next less mantissa from the mantissa of the given logarithm, and call the remainder the P. P. Looking in the secondary table headed P. P. for the column headed by the difference just found, find the number opposite the P. P. just found (or the P. P. corresponding most*

*nearly to that just found); this number is the fifth figure of the required number; the fourth figure will be found at the top of the column containing the next less mantissa, and the first three figures in the column headed N, and in the same row which contains the next less mantissa.*

(c) *Having found the figures of the number as above directed, locate the decimal point by the rules for the characteristic, annexing ciphers to bring the number up to the required number of figures if the characteristic is greater than 4.*

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## RULES FOR USING TRIGONOMETRIC TABLES.

**Given, an angle, to find its sine, cosine, tangent, and cotangent.**

**Rule 11.**—*Find in the table the sine, cosine, tangent, or cotangent corresponding to the degrees and minutes of the angle.*

*For the seconds, find the difference of the values of the sine, cosine, tangent, or cotangent taken from the table, between which the seconds of the angle fall; multiply this difference by a fraction whose numerator is the number of seconds in the given angle, and whose denominator is 60.*

*If sine or tangent, add this correction to the value first found; if cosine or cotangent, subtract the correction.* Art. **756.**

**Given, the sine, cosine, tangent, or cotangent to find the angle corresponding.**

To find the angle corresponding to a given sine, cosine, tangent, or cotangent whose exact value is not contained in the table:

**Rule 12.**—*Find the difference of the two numbers in the table between which the given sine, cosine, tangent, or cotangent falls, and use the number of parts in this difference as the denominator of a fraction.*

*Find the difference between the number belonging to the* **smaller angle,** *and the given sine, cosine, tangent, or cotangent, and use the number of parts in the difference just found as the numerator of the fraction mentioned above. Multiply this fraction by 60, and the result will be the number of seconds to be added to the* **smaller angle.** Art. **758.**

## RULES FOR MENSURATION.

### THE TRIANGLE.

**Rule.**—*The area of any triangle equals one-half the product of the base and the altitude.* Art. **766.**

### THE QUADRILATERAL.

To find the area of a parallelogram:

**Rule.**—*The area of any parallelogram equals the product of the base and the altitude.* Art. **777.**

To find the area of a trapezoid:

**Rule.**—*The area of a trapezoid equals one-half the sum of the parallel sides multiplied by the altitude.* Art. **778.**

To find the area of an irregular figure bounded by straight lines:

**Rule.**—*Divide the figure into triangles, and find the area of each triangle separately. The sum of the areas of all the triangles will be the area of the figure.* Art. **779.**

### THE CIRCLE.

To find the circumference or diameter of a circle:

**Rule.**—*The circumference of a circle equals the diameter multiplied by 3.1416.* Art. **780.**

**Rule.**—*The diameter of a circle equals the circumference divided by 3.1416.* Art. **780.**

To find the length of an arc of a circle:

**Rule.**—*The length of an arc of a circle equals the circumference of the circle of which the arc is a part multiplied by the number of degrees in the arc, and divided by 360.* Art. **781.**

To find the area of a circle:

**Rule.**—*Square the diameter, and multiply by .7854.* Art. **782.**

Given, the area of a circle to find its diameter:

**Rule.**—*Divide the area by .7854, and extract the square root of the quotient.* Art. **783.**

To find the area of a sector:

**Rule.**—*Divide the number of degrees in the arc of a sector by 360. Multiply the result by the area of the circle of which the sector is a part.* Art. **784.**

To find the area of a segment of a circle:

**Rule.**—*Draw radii from the center of the circle to the extremities of the arc of the segment; find the area of the sector thus formed, subtract from this the area of the triangle formed by the radii and the chord of the arc of the segment, and the result is the area of the segment.* Art. **785.**

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### THE ELLIPSE.

To find the perimeter of an ellipse:

**Rule.**—*Multiply the major axis by 1.82, and the minor axis by 1.315. The sum of the results will be the perimeter.* Art. **788.**

To find the exact area of an ellipse:

**Rule.**—*The area of an ellipse is equal to the product of its two diameters multiplied by .7854.* Art. **789.**

To find the area of any plane figure:

**Rule.**—*The area of any plane figure may be found by dividing it into triangles, quadrilaterals, circles or parts of circles, and ellipses, finding the area of each part separately, and adding them together.* Art. **790.**

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### THE PRISM AND CYLINDER.

To find the area of the convex surface of any right prism or right cylinder:

**Rule.**—*Multiply the perimeter of the base by the altitude.* Art. **803.**

To find the volume of a right prism or cylinder:

**Rule.**—*The volume of any right prism or cylinder equals the area of the base multiplied by the altitude.* Art. **804.**

### THE PYRAMID AND CONE.

To find the area of a right pyramid or right cone:

**Rule.**—*The convex area of a right pyramid or cone equals the perimeter of the base multiplied by one-half the slant height.* Art. **809.**

To find the volume of a right pyramid or cone:

**Rule.**—*The volume of a right pyramid or cone equals the area of the base multiplied by one-third of the altitude.* Art. **810.**

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### THE FRUSTUM OF A PYRAMID OR CONE.

To find the convex area of a frustum of a right pyramid or right cone:

**Rule.**—*The convex area of a frustum of a right pyramid or right cone equals one-half the sum of the perimeters of its bases multiplied by the slant height of the frustum.* Art. **814.**

To find the volume of the frustum of a pyramid or cone:

**Rule.**—*Add the areas of the upper base, the lower base, and the square root of the product of the areas of the two bases; multiply this sum by one-third of the altitude.* Art. **815.**

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### THE SPHERE.

To find the area of the surface of a sphere:

**Rule.**—*The area of the surface of a sphere equals the square of the diameter multiplied by 3.1416.* Art. **817.**

To find the volume of a sphere:

**Rule.**—*The volume of a sphere equals the cube of the diameter multiplied by .5236.* Art. **818.**

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## FORMULAS USED IN ELEMENTARY MECHANICS.

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### UNIFORM MOTION.

**Let** $S$ = the length of space passed over uniformly;
$t$ = the time occupied in passing over the space $S$;
$V$ = the velocity.

$$V = \frac{S}{t}. \qquad (7.) \text{ Art. } \mathbf{859.}$$

$$S = Vt. \qquad (8.) \text{ Art. } \mathbf{859.}$$

$$t = \frac{S}{V}. \qquad (9.) \text{ Art. } \mathbf{859.}$$

---

### MASS, WEIGHT, AND GRAVITY.

If the mass of the body be represented by $m$, its weight by $W$, and the force of gravity at the place where the body was weighed by $g$, we have

$$\text{mass} = \frac{\text{weight of body}}{\text{force of gravity}}, \text{ or } m = \frac{W}{g}. \qquad (10.) \text{ Art. } \mathbf{888.}$$

---

### FORMULAS FOR GRAVITY PROBLEMS.

Let $W$ = weight of body at the surface;
$w$ = weight of a body at a given distance above or below the surface;
$d$ = distance between the center of the earth and the center of the body;
$R$ = radius of the earth = 4,000 miles.

Formula for weight when the body is below the surface:

$$w\,R = d\,W. \qquad (11.) \text{ Art. } \mathbf{891.}$$

Formula for weight when the body is above the surface:

$$w\,d^2 = W\,R^2. \qquad (12.) \text{ Art. } \mathbf{891.}$$

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### FALLING BODIES.

Let $g$ = force of gravity = constant accelerating force due to the attraction of the earth;
$t$ = number of seconds the body falls;
$v$ = velocity at the end of the time $t$;
$h$ = distance that a body falls during the time $t$.

$$v = g\,t. \qquad (13.) \text{ Art. } \mathbf{896.}$$

*That is, the velocity acquired by a freely falling body at the end of t seconds equals 32.16 multiplied by the time in seconds.*

$$t = \frac{v}{g}. \qquad (14.) \text{ Art. } \mathbf{896.}$$

*That is, the number of seconds during which a body must have fallen to acquire a given velocity equals the given velocity in feet per second divided by 32.16.*

$$h = \frac{v^2}{2g}. \qquad \textbf{(15.)} \text{ Art. } \textbf{896.}$$

*That is, the height from which a body must fall to acquire a given velocity equals the square of the given velocity divided by 2 × 32.16.*

$$v = \sqrt{2gh}. \qquad \textbf{(16.)} \text{ Art. } \textbf{896.}$$

*That is, the velocity that a body will acquire in falling through a given height equals the square root of the product of twice 32.16 and the given height.*

$$h = \tfrac{1}{2} g t^2. \qquad \textbf{(17.)} \text{ Art. } \textbf{896.}$$

*That is, the distance a body will fall in a given time equals 32.16 ÷ 2 multiplied by the square of the number of seconds.*

$$t = \sqrt{\frac{2h}{g}}. \qquad \textbf{(18.)} \text{ Art. } \textbf{896.}$$

*That is, the time it will take a body to fall through a given height equals the square root of twice the height divided by 32.16.*

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### CENTRIFUGAL FORCE.

The value of the centrifugal force of any revolving body, expressed in pounds, is

$$F = .00034\, W R N^2; \qquad \textbf{(19.)} \text{ Art. } \textbf{903.}$$

in which $F$ = centrifugal force;
$W$ = total weight of body in pounds;
$R$ = radius, usually taken as the distance between the center of motion and the center of gravity of the revolving body, in feet;
$N$ = number of revolutions per *minute.*

### THE CENTER OF GRAVITY OF TWO BODIES.

Let $l$ = the distance between the centers of the bodies;
$l_1$ = the short arm;
$w$ = weight of small body;
$W$ = weight of large body.

$$l_1 = \frac{w\,l}{W + w}. \qquad \textbf{(20.)} \quad \text{Art. } \textbf{911.}$$

### THE EFFICIENCY OF A MACHINE.

Let $F$ = the force applied to the machine;
$V$ = the velocity ratio of the machine;
$W$ = the weight actually lifted or equivalent resistance overcome;
$\mathbf{E}$ = the efficiency of the machine;

$$\text{Then, } \mathbf{E} = \frac{W}{F\,V}. \qquad \textbf{(22.)} \quad \text{Art. } \textbf{950.}$$

### WORK.

If the force necessary to overcome the resistance be represented by $F$, the space through which the resistance acts by $S$, and the work done by $U$, then $U = F\,S$.

If $W$ = the weight of a body, and $h$ = the height through which it is raised, $U = W\,h$. Hence the work done

$$U = F\,S = W\,h. \qquad \textbf{(23.)} \quad \text{Art. } \textbf{953.}$$

### POWER.

The power of a machine may always be determined by *dividing the work done in foot-pounds by the time in minutes required to do the work; i. e.,*

$$\text{Power} = \frac{F\,S}{T}. \qquad \textbf{(24.)} \quad \text{Art. } \textbf{954.}$$

### KINETIC ENERGY.

Let $W$ = the weight of the body in pounds;
$v$ = its velocity in feet per second;
$h$ = the height in feet through which the body must fall to produce the velocity $v$;
$m$ = the mass of the body $= \frac{W}{g}$. (See formula **10.**)

The work necessary to raise a body through a height $h$ is $Wh$. The velocity produced in falling a height $h$ is $v = \sqrt{2gh}$, and $h = \frac{v^2}{2g}$. (See formulas **15** and **16.**)

Therefore, work $= Wh = W\frac{v^2}{2g} = \frac{1}{2} \times \frac{W}{g} \times v^2 = \frac{1}{2} m v^2$, or

$$Wh = \tfrac{1}{2} m v^2. \qquad \textbf{(25.)} \quad \text{Art. } \textbf{957.}$$

---

### DENSITY.

The **density of a body** is its mass divided by its volume in cubic feet.

Let $D$ be the density; then the density of a body is

$$D = \frac{m}{V}. \quad \text{Since } m = \frac{W}{g},\ D = \frac{W}{gV}. \qquad \textbf{(26.)} \quad \text{Art. } \textbf{962.}$$

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## RULES AND FORMULAS USED IN HYDRO-MECHANICS.

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### PASCAL'S LAW.

**Rule I.**—*The pressure per unit of area exerted anywhere upon a mass of liquid is transmitted undiminished in all directions, and acts with the same force upon all surfaces in a direction at* **right angles** *to those surfaces.*

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### THE GENERAL LAW FOR THE DOWNWARD PRESSURE UPON THE BOTTOM OF ANY VESSEL.

**Rule II.**—*The pressure upon the bottom of a vessel containing a fluid is independent of the shape of the vessel, and is equal to the weight of a prism of the fluid whose base has the same area as the bottom of the vessel, and whose altitude is the distance between the bottom and the upper surface of the fluid plus the pressure per unit of area upon the upper surface of the fluid multiplied by the area of the bottom of the vessel.*

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### GENERAL LAW FOR UPWARD PRESSURE.

**Rule III.**—*The upward pressure on any submerged horizontal surface equals the weight of a prism of the liquid*

*whose base has an area equal to the area of the submerged surface, and whose altitude is the distance between the submerged surface and the upper surface of the liquid plus the pressure per unit of area on the upper surface of the fluid multiplied by the area of the submerged surface.*

---

### GENERAL LAW FOR LATERAL PRESSURE.

**Rule IV.**—*The pressure upon any vertical surface due to the weight of a liquid is equal to the weight of a prism of the liquid whose base has the same area as the vertical surface, and whose altitude is the depth of the center of gravity of the vertical surface below the level of the liquid.*

*Any additional pressure is to be added as in the previous cases.*

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### GENERAL LAW FOR PRESSURE.

**Rule V.**—*The pressure exerted by a fluid in any direction upon any surface is equal to the weight of a prism of the fluid whose base is the projection of the surface at right angles to the direction considered, and whose height is the depth of the center of gravity of the surface below the level of the liquid.*

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### SPECIFIC GRAVITY.

Let $W$ be the weight of the solid in air and $W'$ the weight in water; then, $W - W'$ = the weight of a volume of water equal to the volume of the solid, and

$$\text{Sp. Gr.} = \frac{W}{W - W'}. \qquad \textbf{(27.)} \quad \text{Art. } \textbf{991.}$$

If the body be lighter than water, a piece of iron or other heavy substance must be attached to it sufficiently heavy to sink both. *Then weigh both bodies in air and both in water.*

Let $W$ = weight of both bodies in air;
$W'$ = weight of both bodies in water;
$w$ = weight of light body in air;
$W_1$ = weight of heavy body in air;
$W_2$ = weight of heavy body in water.

Then, the specific gravity of the light body is given by

$$\text{Sp. Gr.} = \frac{w}{(W - W') - (W_1 - W_2)}. \qquad \textbf{(28.)} \quad \text{Art. } \textbf{992.}$$

To find the specific gravity of a liquid:

*Weigh an empty flask; fill it with water, then weigh it, and find the difference between the two results; this will equal the weight of the water. Then weigh the flask filled with the liquid and subtract the weight of the flask; the result is the weight of a volume of the liquid equal to the volume of the water. The weight of the liquid divided by the weight of the water is the specific gravity of the liquid.*

Let $W$ = the weight of the flask and liquid;
$W'$ = the weight of the flask and water;
$w$ = the weight of the flask.

Then,
$$\text{Sp. Gr.} = \frac{W - w}{W' - w}. \qquad \textbf{(29.)} \quad \text{Art. } \textbf{993.}$$

## FORMULAS FOR FLOW OF WATER.

### MEAN VELOCITY.

Let $Q$ = the quantity in cubic feet which passes any section in 1 second;
$A$ = the area of the section in square feet;
$v_m$ = the mean velocity in feet per second.

Then,
$$Q = A\,v_m, \qquad \textbf{(31.)} \quad \text{Art. } \textbf{1003.}$$

and
$$v_m = \frac{Q}{A}. \qquad \textbf{(32.)} \quad \text{Art. } \textbf{1003.}$$

### VELOCITY OF EFFLUX FROM AN ORIFICE.

Let $v$ = the velocity of efflux in feet per second;
$h$ = the head in feet on the orifice considered;
$h_1$ = the head equivalent to a pressure $p$;
$W$ = the weight of the water in pounds flowing through the aperture per second.

The kinetic energy of the issuing water $= \dfrac{Wv^2}{2g}$.

The work the issuing water can do $= W h$.

$$W h = \frac{W v^2}{2g}, \text{ or } v = \sqrt{2gh}.$$

$h = \frac{p}{.434}$, where $h_1$ is in feet, and $p$ in pounds per square inch.

$h_1 = \frac{p}{62.5}$, where $h_1$ is in feet, and $p$ in pounds per square foot.

$h + h_1 =$ the *total head.*

$$v = \sqrt{2g(h_1 + h)}. \qquad \textbf{(33.)} \text{ Art. } \textbf{1007.}$$

If $a$ is the area of a large orifice in the bottom of a small vessel whose area is $A$, the velocity is

$$v\sqrt{\frac{2gh}{1 - \frac{a^2}{A^2}}}. \qquad \textbf{(35.)} \text{ Art. } \textbf{1010.}$$

Actual velocity of efflux from a small square-edged orifice:

$$v = .98\sqrt{2gh}. \qquad \textbf{(36.)} \text{ Art. } \textbf{1013.}$$

Actual quantity discharged from a small square-edged orifice:

$$Q = .615\, A\, v. \qquad \textbf{(37.)} \text{ Art. } \textbf{1015.}$$

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### THEORETICAL AND ACTUAL DISCHARGE.

Let $Q$ = theoretical number of cubic feet discharged per second;

$v_m$ = theoretical mean velocity through orifice in feet per second $= Q \div A$;

$A$ = area of orifice in square feet;

$h$ = theoretical head necessary to give a mean velocity $v_m$.

$Q_a$ = actual quantity discharged in cubic feet per second.

Then, for an orifice in a thin plate, or a square-edged orifice (the hole itself may be of any shape, triangular,

square, circular, etc., but the edges must not be rounded), the actual quantity discharged is:

$$Q_a = .615\,Q = .615\,A\,v_m = .615\,A\sqrt{2gh}. \qquad \textbf{(38.)}$$

Art. **1017.**

For a discharge through a short tube,

$$Q_a = .815\,Q = .815\,A\,v_m = .815\,A\sqrt{2gh}. \qquad \textbf{(39.)}$$ Art. **1017.**

For a discharge through a mouthpiece,

$$Q_a = .97\,Q = .97\,A\,v_m = .97\,A\sqrt{2gh}. \qquad \textbf{(40.)}$$ Art. **1017.**

For a discharge through the compound mouthpiece, the area of the orifice being taken as the area of the smallest section,

$$Q_a = 1.5526\,Q = 1.5526\,A\,v_m = 1.5526\,A\sqrt{2gh}. \qquad \textbf{(41.)}$$

Art. **1017.**

In these four formulas it is taken for granted that there is a constant head.

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### FLOW OF WATER THROUGH WEIRS.

If $d =$ the depth of the opening in feet, and $b$ its breadth in feet, the area of the opening is $A = d \times b$, and the theoretical discharge is $Q = d \times b \times v_m = db \times \frac{2}{3}\sqrt{2gh} = \frac{2}{3}bd\sqrt{2gd}$, the head for this case being taken as $d$.

The actual discharge is

$$Q_a = .615\,Q = .615 \times \tfrac{2}{3}bd\sqrt{2gd} = .41\,b\sqrt{2gd^3}. \qquad \textbf{(42.)}$$

Art. **1020.**

That is, *the actual discharge through a weir in cubic feet per second, whose top is on a level with the upper surface of the water, is equal to .41 multiplied by the breadth of the weir, multiplied by the square root of 2 g times the cube of the depth of the weir. All dimensions are to be taken in feet.*

To obtain the mean velocity $v_m$, divide the actual discharge by the area of the weir, or

$$v_m = \frac{Q_a}{A} = \frac{Q_a}{bd}. \qquad \textbf{(43.)}$$ Art. **1020.**

For a weir whose upper edge is below the level of the upper surface of the water, let $h_1$ be the depth in feet of the top of the weir below the surface of the water, and $h$ the depth in feet of the bottom of the weir below the surface of the water. The actual discharge $Q_a$ in cubic feet per second is

$$Q_a = .41\, b \sqrt{2g}\,(\sqrt{h^3} - \sqrt{h_1^3}). \qquad \textbf{(44.)} \quad \text{Art. } \textbf{1022.}$$

## FLOW OF WATER IN PIPES.

### THE MEAN VELOCITY OF DISCHARGE.

For straight cylindrical pipes of uniform diameter:

Let $v_m$ = mean velocity of discharge in feet per second;
$h$ = total head in feet = the vertical distance between the level of the water in the reservoir and the point of discharge;
$l$ = length of pipe in feet;
$d$ = diameter of pipe in inches;
$f$ = coefficient of friction.

Then, $$v_m = 2.315 \sqrt{\frac{h\,d}{f\,l + \frac{1}{8}\,d}}. \qquad \textbf{(45.)} \quad \text{Art. } \textbf{1024.}$$

When the pipe is very long, compared with the diameter, the following formula may be used:

$$v_m = 2.315 \sqrt{\frac{h\,d}{f\,l}}. \qquad \textbf{(46.)} \quad \text{Art. } \textbf{1027.}$$

### THE ACTUAL HEAD.

The actual head necessary to produce a certain velocity $v_m$ may be calculated by the formula

$$h = \frac{f\,l\,v^2_m}{5.36\,d} + .0233\,v^2_m. \qquad \textbf{(47.)} \quad \text{Art. } \textbf{1029.}$$

### THE QUANTITY DISCHARGED FROM PIPES.

Let $d$ = the diameter of the pipe in inches, then the discharge $Q$ in gallons per second is

$$Q = .0408\,d^2\,v_m. \qquad \textbf{(48.)} \quad \text{Art. } \textbf{1030.}$$

If the diameter of the pipe and the discharge are known, the mean velocity $v_m$ is

$$v_m = \frac{24.51\,Q}{d^2}. \qquad \textbf{(49.)} \text{ Art. } \textbf{1031.}$$

If the head, the length of the pipe, and the diameter of the pipe are given, to find the discharge use the formula

$$Q = .09445\,d^2\sqrt{\frac{h\,d}{f\,l + \frac{1}{8}d}}. \qquad \textbf{(50.)} \text{ Art. } \textbf{1032.}$$

To find the value of $f$, calculate $v_m$ by formula **46,** assuming that $f = .025$, and get the final value of $f$ from the following table. Art. **1033.**

| | | | | | | |
|---|---|---|---|---|---|---|
| $v_m =$ | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 |
| $f =$ | .0686 | .0527 | .0457 | .0415 | .0387 | .0365 |
| $v_m =$ | 0.7 | 0.8 | 0.9 | 1 | $1\frac{1}{4}$ | $1\frac{1}{2}$ |
| $f =$ | .0349 | .0336 | .0325 | .0315 | .0297 | .0284 |
| $v_m =$ | 2 | 3 | 4 | 6 | 8 | 12 |
| $f =$ | .0265 | .0243 | .0230 | .0214 | .0205 | .0193 |

NOTE.—The values given in the above table are calculated by the formula $f = .014392 + \frac{.017156}{\sqrt{v_m}}$.

### TO CALCULATE THE DIAMETER OF A PIPE.

Neglecting the fraction $\frac{1}{8}\,d$ in formula **50,** and solving for $d$,

$$d = 2.57\sqrt[5]{\frac{f\,l\,Q^2}{h}}.$$

Assuming that $f = .025$, for a trial value, the above equation then becomes

$$d = 1.229\sqrt[5]{\frac{l\,Q^2}{h}}. \qquad \textbf{(51.)} \text{ Art. } \textbf{1035.}$$

Formula **50** may also be written

$$d = 2.57 \sqrt[5]{\frac{(fl + \frac{1}{3}d)\,Q^2}{h}}. \qquad (52.) \text{ Art. } \mathbf{1035.}$$

By aid of formulas **51** and **52**, the diameter of a pipe may be approximated as follows:

**Rule.**—*Find the value of d by formula* ***51****; substitute this value in formula* ***49****, and find the value of* $v_m$. *Then find from the table the value of f corresponding to this value of* $v_m$. *Substitute the values of d and f just found in the right-hand member of formula* ***52****, and solve for d; the result will be the diameter of the pipe, nearly enough for all practical purposes.*

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## FORMULAS USED IN PNEUMATICS.

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### PRESSURE, VOLUME, DENSITY, AND WEIGHT OF AIR WHEN THE TEMPERATURE IS CONSTANT:

**Mariotte's Law.**—*The temperature remaining the same, the volume of a given quantity of gas varies inversely as the pressure.*

Let $p$ = pressure for one position of the piston;
$p_1$ = pressure for any other position of the piston;
$v$ = volume corresponding to the pressure $p$;
$v_1$ = volume corresponding to the pressure $p_1$.

$$\text{Then, } p\,v = p_1\,v_1. \qquad (53.) \text{ Art. } \mathbf{1049.}$$

Let $D$ be the density corresponding to the pressure $p$ and volume $v$, and $D_1$ be the density corresponding to the pressure $p_1$ and volume $v_1$; then,

$$p : D = p_1 : D_1, \text{ or } p\,D_1 = p_1\,D, \qquad (54.) \text{ Art. } \mathbf{1052.}$$

$$\text{and } v : D_1 = v_1 : D, \text{ or } v\,D = v_1\,D_1. \qquad (55.) \text{ Art. } \mathbf{1052.}$$

Thus, let $W$ be the weight of a cubic foot of air or other gas, whose volume is $v$, and pressure is $p$; let $W_1$ be the weight of a cubic foot when the volume is $v_1$, and pressure is $p_1$; then,

$$p\,W_1 = p_1\,W. \qquad (56.) \text{ Art. } \mathbf{1052.}$$

$$v\,W = v_1\,W_1. \qquad (57.) \text{ Art. } \mathbf{1052.}$$

**PRESSURE AND VOLUME OF A GAS WITH VARIABLE TEMPERATURE:**

**Gay-Lussac's Law.**—*If the pressure remains constant, every increase of temperature of 1° F. produces in a given quantity of gas an expansion of $\frac{1}{492}$ of its volume at 32° F.*

If the pressure remains constant it will also be found that every decrease of temperature of 1° F. will cause a decrease of $\frac{1}{492}$ of the volume at 32° F.

Let $v$ = original volume of gas;
$v_1$ = final volume of gas;
$t$ = temperature corresponding to volume $v$;
$t_1$ = temperature corresponding to volume $v_1$.

Then, $$v_1 = v\left(\frac{460 + t_1}{460 + t}\right). \qquad \textbf{(58.)} \text{ Art. } \textbf{1054.}$$

That is, *the volume of gas after heating (or cooling) equals the original volume multiplied by 460 plus the final temperature divided by 460 plus the original temperature.*

Let $p$ = the original tension;
$t$ = the corresponding temperature;
$p_1$ = final tension;
$t_1$ = final temperature.

Then, $$p_1 = p\left(\frac{460 + t_1}{460 + t}\right). \qquad \textbf{(59.)} \text{ Art. } \textbf{1055.}$$

Let $p$ = pressure in pounds per square inch;
$V$ = volume of air in cubic feet;
$T$ = absolute temperature;
$W$ = weight in pounds.

Then, $$p\,V = .37052\,T. \qquad \textbf{(60.)} \text{ Art. } \textbf{1056.}$$

If the weight of the air be greater or less than 1 pound, the following formula must be used:

$$p\,V = .37052\,W\,T. \qquad \textbf{(61.)} \text{ Art. } \textbf{1057.}$$

Let $p_1$, $V_1$, and $T_1$ represent the pressure, volume, and temperature of the same weight of air in another state; then,

$$\frac{p\,V}{T} = \frac{p_1\,V_1}{T_1}. \qquad \textbf{(62.)} \text{ Art. } \textbf{1058.}$$

### MIXTURE OF TWO GASES HAVING UNEQUAL VOLUMES AND PRESSURES.

Let $v$ and $p$ be the volume and pressure, respectively, of one of the gases.

Let $v_1$ and $p_1$ be the volume and pressure, respectively, of the other gas.

Let $V$ and $P$ be the volume and pressure, respectively, of the mixture. Then, if the temperature remains the same,

$$VP = vp + v_1 p_1. \quad \textbf{(63.)} \quad \text{Art. } \textbf{1062.}$$

### MIXTURE OF TWO VOLUMES OF AIR HAVING UNEQUAL PRESSURES, VOLUMES, AND TEMPERATURES.

If a body of air having a temperature $t_1$, a pressure $p_1$, and a volume $v_1$, be mixed with another volume of air having a temperature $t_2$, a pressure $p_2$, and a volume $v_2$, to form a volume $V$ having a pressure $P$, and a temperature $t$, then, either the new temperature $t$, the new volume $V$, or the new pressure $P$ may be found, if the other two quantities are known, by the following formula, in which $T_1$, $T_2$, and $T$ are the absolute temperatures corresponding to $t_1$, $t_2$, and $t$:

$$PV = \left[\frac{p_1 v_1}{T_1} + \frac{p_2 v_2}{T_2}\right] T. \quad \textbf{(64.)} \quad \text{Art. } \textbf{1063.}$$

## FORMULAS USED IN HEAT.

### TO CHANGE FAHRENHEIT TEMPERATURES TO CENTIGRADE, AND CENTIGRADE TO FAHRENHEIT.

Let $t_c$ = temperature Centigrade, and $t_f$ = temperature Fahrenheit. Then,

$$t_f = \tfrac{9}{5}\, t_c + 32^\circ, \quad \textbf{(65.)} \quad \text{Art. } \textbf{1104.}$$

$$\text{and } t_c = (t_f - 32^\circ)\, \tfrac{5}{9}. \quad \textbf{(66.)} \quad \text{Art. } \textbf{1104.}$$

### EXPANSION OR CONTRACTION OF BODIES FROM CHANGES OF TEMPERATURE.

Let $L$ = length of any body;

$l$ = amount of expansion or contraction due to heating or cooling the body;

$A$ = area of any section of the body;

$a$ = increase or decrease of area of the same section after heating or cooling the body;
$V$ = volume of the body;
$v$ = increase or decrease in volume due to heating or cooling the body;
$C_1$ = coefficient of expansion taken from column 1, Table 1;
$C_2$ = coefficient taken from column 2, Table 1;
$C_3$ = coefficient taken from column 3, Table 1;
$t$ = difference in degrees of temperature between the original temperature and the temperature of the body after it has been heated or cooled.

Then, $l = L\,C_1\,t$; **(67.)** Art. **1113.**

$a = A\,C_2\,t$; **(68.)** Art. **1113.**

$v = V\,C_3\,t$. **(69.)** Art. **1113.**

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**RESULTING TEMPERATURES AND SPECIFIC HEATS OF THE MIXTURE OF SEVERAL BODIES HAVING UNEQUAL TEMPERATURES.**

$$t = \frac{W_1 s_1 t_1 + W_2 s_2 t_2 + W_3 s_3 t_3 + \text{etc.}}{W_1 s_1 + W_2 s_2 + W_3 s_3 + \text{etc.}}, \quad \left\{ \begin{array}{l} \textbf{(73.)} \\ \text{Art. } \textbf{1136.} \end{array} \right.$$

$$\text{or } s_3 = \frac{W_1 s_1 (t_1 - t) + W_2 s_2 (t_2 - t) + \text{etc.}}{W_3 (t - t_3)}, \quad \left\{ \begin{array}{l} \textbf{(74.)} \\ \text{Art. } \textbf{1137.} \end{array} \right.$$

in which $t$ is the final temperature of the mixture; $W_1$, $s_1$, and $t_1$, the weight, specific heat, and temperature, respectively, of one body; $W_2$, $s_2$, and $t_2$ the same for second body; and $W_3$, $s_3$, and $t_3$ the same for a third body, etc.

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**WORK DONE BY THE ISOTHERMAL EXPANSION OF A GAS.**

$L$ = the work in foot-pounds;
$P$ = the total initial pressure in pounds per square foot;
$P_1$ = the total final pressure in pounds per square foot;
$V$ = the initial volume in cubic feet;
$V_1$ = the final volume in cubic feet.

$$L = 2.3026\,P\,V \log \frac{V_1}{V}. \qquad \textbf{(75.)} \text{ Art. } \textbf{1160.}$$

Since $PV = P_1 V_1$, $\frac{P}{P_1} = \frac{V_1}{V}$, and formula **75** might be written

$$L = 2.3026\, PV \log \frac{P}{P_1}. \qquad \textbf{(76.)} \text{ Art. } \textbf{1160.}$$

Whichever formula is used it must be kept in mind that the fraction $\frac{V_1}{V}$ or $\frac{P}{P_1}$ must *always be greater than 1; that is, the numerator must always be greater than the denominator.*

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**WORK REQUIRED TO COMPRESS A GAS ISOTHERMALLY.**

$$L = 2.3026\, PV \log \frac{V}{V_1}, \qquad \textbf{(77.)} \text{ and}$$

$$L = 2.3026\, PV \log \frac{P_1}{P}, \qquad \textbf{(78.)} \text{ Art. } \textbf{1162.}$$

in which the letters have the same meaning as before, and *the larger volume or pressure is always in the numerator.*

Formulas **75, 76, 77,** and **78** will be easier to use if the pressure be taken in pounds per square inch, and $144 \times 2.3026 = 331.5744$ be substituted for 2.3026. As before, the volume must always be taken in cubic feet. Formulas **75** and **76** then become

$$L = 331.5744\, p\, V \log \frac{V_1}{V}, \qquad \textbf{(79.)}$$

$$L = 331.5744\, p\, V \log \frac{p}{p_1}, \qquad \textbf{(80.)} \text{ Art. } \textbf{1163.}$$

in which $p$ = pressure in pounds per square inch.

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**RELATION BETWEEN PRESSURES AND VOLUMES OF AIR DURING ADIABATIC EXPANSION OR COMPRESSION.**

Let $p$ and $v$ = the volume and pressure during one stage;

$p_1$ and $v_1$ = the volume and pressure during the next stage;

$p_2$ and $v_2$ = the volume and pressure during the third stage, etc.;

then $p\, v^{1.41} = p_1\, v_1^{1.41} = p_2\, v_2^{1.41} =$ etc. **(81.)** Art. **1164.**

**WORK DONE BY THE ADIABATIC EXPANSION OF AIR.**

Let $L$ = work in foot-pounds;
$P$ = initial pressure in pounds per square foot;
$P_1$ = final pressure in pounds per square foot;
$V$ = initial volume in cubic feet;
$V_1$ = final volume in cubic feet.

$$L = 2.44\,PV\left[1 - \left(\frac{V}{V_1}\right)^{.41}\right], \qquad \textbf{(82.)} \text{ Art. } \textbf{1165.}$$

$$L = 2.44\,PV\left[1 - \left(\frac{P_1}{P}\right)^{.29078}\right]. \qquad \textbf{(83.)} \text{ Art. } \textbf{1166.}$$

Let $p$ and $p_1$ be the initial and final pressures, respectively, in pounds per square inch, then,

$$L = 351.36\,p\,V\left[1 - \left(\frac{V}{V_1}\right)^{.41}\right], \qquad \textbf{(84.)}$$

$$L = 351.36\,p\,V\left[1 - \left(\frac{p_1}{p}\right)^{.29078}\right]. \qquad \textbf{(85.)} \text{ Art. } \textbf{1167.}$$

The relation between the pressures and temperatures, and the volumes and temperatures, during the adiabatic expansion of air, are given by the following formulas:

$$\left(\frac{P}{P_1}\right)^{.29078} = \frac{T}{T_1}. \qquad \textbf{(86.)} \text{ Art. } \textbf{1170.}$$

$$\left(\frac{V_1}{V}\right)^{.41} = \frac{T}{T_1}. \qquad \textbf{(87.)} \text{ Art. } \textbf{1170.}$$

To obtain the area of the diagram representing the adiabatic compression of air, the following formula may be used which gives it directly when $p$ and $p_1$ are the greater and lesser pressures, respectively, and $V$ and $V_1$ their corresponding volumes:

$$\frac{pV - p_1V_1}{.41} = \text{area}. \qquad \textbf{(88.)} \text{ Art. } \textbf{1172.}$$

**EFFICIENCY OF A PERFECT HEAT ENGINE.**

Let $c = \frac{P_1V_1}{T_1}$, and $r = \frac{V_2}{V_1}$, then, the efficiency of a perfect heat engine $= \frac{2.3026\,c \log r_1 (T_1 - T_2)}{2.3026\,c\,T_1 \log r_1} = E = \frac{T_1 - T_2}{T_1}$. **(89.)** Art. **1182.**

That is, *for a perfect heat engine, operating through a reversible cycle process, the efficiency of the machine is the ratio of the difference of the absolute temperatures of the sources of heat and of cold to the absolute temperature of the source of heat.*

## FORMULAS USED IN STEAM AND STEAM ENGINES.

### RELATION BETWEEN THE PRESSURE AND TEMPERATURE OF SATURATED STEAM.

Let $t$ = temperature, Fahrenheit;

$T$ = absolute temperature = $t + 460°$;

$p$ = absolute pressure (pressure above vacuum) in pounds per sq. in.

$$\text{Log}\, p = 6.1007 - \frac{2{,}719.78}{T} - \frac{400{,}215}{T^2}. \quad \left\{ \begin{array}{l} \textbf{(90.)} \\ \text{Art. } \textbf{1197.} \end{array} \right.$$

### TOTAL HEAT OF VAPORIZATION.

Let $H$ = total heat of vaporization;

$t$ = temperature;

$$H = 1{,}081.94 + .305\, t. \qquad \textbf{(91.)} \quad \text{Art. } \textbf{1200.}$$

### SPECIFIC VOLUME OF SATURATED STEAM.

$$p\, V^{\frac{17}{16}} = 475, \quad \textbf{(92.)} \qquad \text{Art. } \textbf{1203.}$$

in which $p$ is the pressure in pounds per square inch, and $V$ the volume in cubic feet of a pound of steam at the given pressure.

### WORK DONE IN THE CYLINDER OF A STEAM ENGINE.

Let $P$ = the pressure on the piston in pounds per sq. ft.;

$p$ = pressure on piston in pounds per sq. in.;

$V$ = volume swept through by the piston;

$W$ = work in foot-pounds.

Then, $$W = P\,V = 144\, p\, V. \qquad \textbf{(93.)} \quad \text{Art. } \textbf{1212.}$$

### RELATION BETWEEN CLEARANCE, CUT-OFF, AND NUMBER OF EXPANSIONS, OR RATIO OF EXPANSION.

Let $e$ = the number of expansions;

$i$ = the clearance, expressed as a per cent. of the stroke;

$k$ = the real cut-off;
$k_1$ = the apparent cut-off;
$r$ = the apparent number of expansions $= \frac{1}{k_1}$.

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at the beginning of the stroke, are known, the M. E. P. may be found approximately by the following formula:

$$\text{M. E. P.} = \frac{.9\,P(1 + 2.3 \log e)}{e} - .9\,p, \qquad \textbf{(99.)}$$

Art. **1269.**

in which $P$ = absolute steam pressure = gauge pressure + 14.7 pounds;
$e$ = ratio of expansion;
$p$ = absolute back pressure.

$p$ is usually taken as about 3 pounds for condensing engines, and 17 pounds for non-condensing engines.

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**RELATION BETWEEN LENGTH OF STROKE, NUMBER OF REVOLUTIONS, AND PISTON SPEED.**

Let $L$ = length of stroke in inches;
$R$ = number of revolutions per minute;
$S$ = piston speed in feet per minute.

$$\left.\begin{aligned} S &= \frac{L\,R}{6}. \\ L &= \frac{6\,S}{R}. \\ R &= \frac{6\,S}{L}. \end{aligned}\right\} \qquad \textbf{(100.)}$$

Art. **1270.**

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**RATIO OF EXPANSION IN A COMPOUND OR TRIPLE-EXPANSION ENGINE.**

Let $e$ = ratio of expansion in high-pressure cylinder;
$E$ = total ratio of expansion;
$v$ = volume of cylinder receiving steam from the boiler;
$V$ = volume of cylinder exhausting into atmosphere or condenser.

Then, $$E = \frac{e\,V}{v}. \qquad \textbf{(102.)}$$

Art. **1298.**

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**RATIO BETWEEN THE CYLINDERS OF A COMPOUND ENGINE.**

Letting the letters have the same meaning as in the last formula, then either of the following formulas may be used:

$$E = 2.72\,\frac{V}{v}, \text{ or } \frac{V}{v} = \frac{E}{2.72}. \qquad \textbf{(103.)} \text{ Art. } \textbf{1306.}$$

$$\frac{V}{v} = \sqrt{E}. \qquad \textbf{(104.)} \text{ Art. } \textbf{1306.}$$

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## AMOUNT OF WATER AND THE COOLING SURFACE FOR CONDENSERS.

### Water Required by a Condenser.

Let $t_1$ = the temperature of departing condensing water;
$t_2$ = the temperature of entering condensing water;
$t_3$ = the temperature of the condensed steam upon leaving the condenser;
$H$ = total heat of one pound of steam at the pressure of the exhaust;
$W$ = the weight of water required per pound of steam condensed.

$$W = \frac{H - t_3 + 32}{t_1 - t_2}. \qquad \textbf{(105.)} \text{ Art. } \textbf{1323.}$$

### Cooling Surface.

Let $S$ = the required surface in square feet;
$W$ = total weight of steam used per hour.

Then, $S = .0944\ W$. **(106.)** Art. **1325.**

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## TO FIND THE WEIGHT OF A FLY-WHEEL.

Let $V_1$ = the greatest velocity of the crank-pin in ft. per sec.;
$V_2$ = the least velocity of the crank-pin in ft. per sec.;
$V_0$ = average velocity of crank-pin in ft. per sec.;
$W$ = required weight of fly-wheel in pounds;
$H$ = the number of foot-pounds per sq. in. of piston represented by the excess of crank effect over the resistance;
$A$ = area of piston in square inches;
$n$ = ratio between radius of fly-wheel and length of crank;

$$E = \frac{V_1 - V_2}{V_0} = \text{coefficient of unsteadiness.}$$

$$W = \frac{A\,H\,g}{n^2\,E\,V_0^2}. \qquad \textbf{(107.)} \text{ Art. } \textbf{1328.}$$

## FORMULAS USED IN STRENGTH OF MATERIALS.

### UNIT STRESS, UNIT STRAIN, AND COEFFICIENT OF ELASTICITY.

Let $P$ = the total stress in pounds;
$A$ = area of cross-section in square inches;
$S$ = unit stress in pounds per square inch;
$l$ = length of body in inches;
$e$ = elongation in inches;
$s$ = unit strain;
$E$ = coefficient of elasticity.

$$S = \frac{P}{A}, \text{ or } P = A\,S. \qquad \textbf{(108.)} \quad \text{Art. } \textbf{1345.}$$

$$s = \frac{e}{l}, \text{ or } e = l s. \qquad \textbf{(109.)} \quad \text{Art. } \textbf{1346.}$$

$$E = \frac{S}{s} = \frac{P}{A} \div \frac{e}{l} = \frac{P l}{A e}. \qquad \textbf{(110.)} \quad \text{Art. } \textbf{1352.}$$

### STRENGTH OF PIPES AND CYLINDERS.

Let $d$ = inside diameter of pipe in inches;
$l$ = length of pipe in inches;
$p$ = pressure in pounds per square inch;
$P$ = total pressure; then $P = p\,l\,d$;
$t$ = thickness of pipe;
$S$ = working strength of the material.

For longitudinal rupture

$$p\,l\,d = 2\,t\,l\,S, \text{ or}$$

$$p\,d = 2\,t\,S. \qquad \textbf{(111.)} \quad \text{Art. } \textbf{1365.}$$

For transverse rupture

$$p\,d = 4\,t\,S. \qquad \textbf{(112.)} \quad \text{Art. } \textbf{1366.}$$

Since, for longitudinal rupture, $p\,d = 2\,t\,S$, it is seen that a cylinder is twice as strong against transverse rupture as against longitudinal rupture.

For pipes and cylinders whose thickness is greater than $\frac{1}{10}$ of the radius, use the following formula, in which $r$ = the inner radius, and the other letters have the same meaning as before.

$$p = \frac{St}{r+t}. \qquad \textbf{(113.)} \text{ Art. } \textbf{1367.}$$

The following formula gives the collapsing pressure in lb. per sq. in. for wrought-iron pipe:

$$p = 9{,}600{,}000 \frac{t^{2.18}}{ld}. \qquad \textbf{(114.)} \text{ Art. } \textbf{1368.}$$

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**MOMENT OF INERTIA, RESISTING MOMENT, AND BENDING MOMENT OF BEAMS.**

Let $I$ = moment of inertia;
$A$ = area of cross-section;
$r$ = radius of gyration;
$c$ = distance from neutral axis to outermost fiber;
$S_4$ = ultimate strength of flexure;
$f$ = factor of safety;
$M$ = bending moment.

$$I = A r^2. \qquad \textbf{(115.)} \text{ Art. } \textbf{1396.}$$

The resisting moment is given by the expression

$$\frac{S}{c} A r^2 = \frac{S}{c} I, \text{ or } S\frac{I}{c}.$$

For the bending moment

$$M = S_4 \frac{I}{c}, \qquad \textbf{(116.)} \text{ Art. } \textbf{1398.}$$

and, when a factor of safety is used,

$$M = \frac{S_4 I}{fc}. \qquad \textbf{(117.)} \text{ Art. } \textbf{1401.}$$

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**DEFLECTION OF A BEAM.**

Let $a$ = a constant depending on the manner of loading the beam and the condition of the ends;
$s$ = the deflection;
$E$ = the coefficient of elasticity;
$l$ = the length of the beam in inches;
$W$ = the total weight supported in pounds;
$I$ = moment of inertia about the neutral axis.

$$s = a \frac{Wl^3}{EI}. \qquad \textbf{(118.)} \text{ Art. } \textbf{1404.}$$

### STRENGTH OF COLUMNS.

Let $W$ = load on a column;
$S_2$ = ultimate strength for compression;
$A$ = area of section of column;
$f$ = factor of safety;
$l$ = length of column in inches;
$g$ = a constant to be taken from table;
$I$ = least moment of inertia of cross-section;
$b$ = length of longer side of a rectangular column;
$d$ = length of shorter side of a rectangular column, or the diameter of a circular column;
$c$ = length of one side of a square column.

$$W = \frac{S_2 A}{f\left(1 + \frac{A l^2}{g I}\right)}. \qquad \textbf{(119.)} \text{ Art. } \textbf{1411.}$$

$$c = \sqrt{\frac{Wf}{2S_2} + \sqrt{\frac{Wf}{S_2}\left(\frac{Wf}{4S_2} + \frac{12 l^2}{g}\right)}}. \qquad \left\{\begin{array}{l}\textbf{(120.)}\\ \text{Art. } \textbf{1413.}\end{array}\right.$$

For a circular column,

$$d = 1.4142\sqrt{\frac{.3183\,Wf}{S_2} + \sqrt{\frac{.3183\,Wf}{S_2}\left(\frac{.3183\,Wf}{S_2} + \frac{16 l^2}{g}\right)}}.$$

**(121.)** Art. **1413.**

For a rectangular column, assume $d$, then,

$$b = \frac{Wf\left(1 + \frac{12 l^2}{d^2 g}\right)}{d S_2}. \qquad \textbf{(122.)} \text{ Art. } \textbf{1413.}$$

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### STRENGTH OF SHAFTS.

Let $d$ = diameter of a round shaft, or side of a square shaft, in inches;
$c$ = a constant taken from Table 31;
$c_1$ = a constant taken from Table 31;
$P$ = a force applied at the end of a lever arm in pounds;
$r$ = length of lever arm in inches;

$H$ = horsepower transmitted by shaft;
$N$ = number of revolutions per minute;
$k$ = a constant taken from Table 32;
$k_1$ = a constant taken from Table 32;
$q$ = a constant taken from Table 32;
$q_1$ = a constant taken from Table 32.

For all solid shafts below 11 inches in diameter use the formula

$$d = c\sqrt[4]{Pr} = c_1\sqrt[4]{\frac{H}{N}}. \qquad \textbf{(123.)} \text{ Art. } \textbf{1415.}$$

If the diameter of a wrought-iron shaft is greater than 12.4″, of a cast-iron shaft greater than 10.3″, or of a steel shaft greater than 13.6″, the following formula should be used:

$$d = k\sqrt[3]{Pr} = k_1\sqrt[3]{\frac{H}{N}}. \qquad \textbf{(124.)} \text{ Art. } \textbf{1416.}$$

If the shaft is hollow (round) either of the two following formulas may be used:

$$P = q\left(\frac{d_1^4 - d_2^4}{d_1 r}\right), \qquad \textbf{(125.)} \text{ Art. } \textbf{1416.}$$

$$\text{or } H = q_1 N\left(\frac{d_1^4 - d_2^4}{d_1}\right). \qquad \textbf{(126.)} \text{ Art. } \textbf{1416.}$$

---

**SHAFTS SUBJECTED TO COMBINED BENDING AND TWISTING.**

Let $B$ = bending moment;
$T$ = twisting moment;
$T_1$ = the twisting moment which would have the same effect as $B$ and $T$ acting together.

Then, $$T_1 = B + \sqrt{B^2 + T^2}. \qquad \textbf{(255.)} \text{ Art. } \textbf{1991.}$$

The twisting moment $T_1$ is called the **ideal twisting moment,** and should be used in place of $Pr$ in formulas **123** and **124** to determine the diameter of a shaft subjected to combined bending and twisting.

**VALUES OF $c$ AND $c_1$ TO BE USED IN FORMULA 123.**

| Material. | $c$ | | $c_1$ | |
|---|---|---|---|---|
| | Round. | Square. | Round. | Square. |
| Wrought Iron ..... | .31 | .272 | 4.92 | 4.31 |
| Cast Iron ..... | .353 | .309 | 5.59 | 4.89 |
| Steel ..... | .297 | .26 | 4.7 | 4.11 |

**VALUES OF $k$, $k_1$, $q$, AND $q_1$ TO BE USED IN FORMULAS 124, 125, AND 126.**

| Material. | $k$ | $k_1$ | $q$ | $q_1$ |
|---|---|---|---|---|
| Wrought Iron ..... | .0909 | 3.62 | 1,335 | .0212 |
| Cast Iron ..... | .1145 | 4.56 | 669 | .0106 |
| Steel ..... | .0828 | 3.3 | 1,767 | .028 |

**STRENGTH OF ROPES AND CHAINS.**

Let $P$ = working or safe load in pounds;
$C$ = circumference of rope in inches;
$d$ = diameter of the link of a chain in inches.

For manila ropes, hemp ropes, or tarred hemp ropes,

$$P = 100\ C^2. \qquad \textbf{(127.)} \quad \text{Art. } \textbf{1417.}$$

For iron wire rope of 7 strands, 19 wires to the strand,

$$P = 600\ C^2. \qquad \textbf{(128.)} \quad \text{Art. } \textbf{1418.}$$

For the best steel wire rope, 7 strands, 19 wires to the strand,

$$P = 1{,}000\ C^2. \qquad \textbf{(129.)} \quad \text{Art. } \textbf{1418.}$$

For open-link chains made from a good quality of wrought iron,

$$P = 12{,}000\ d^2, \qquad \textbf{(130.)} \quad \text{Art. } \textbf{1421.}$$

and for stud-link chains,

$$P = 18{,}000\ d^2. \qquad \textbf{(131.)} \quad \text{Art. } \textbf{1421.}$$

## FORMULAS USED IN APPLIED MECHANICS.

### RELATION BETWEEN THE DIAMETERS AND NUMBER OF REVOLUTIONS OF PULLEYS.

Let $D_1$ = diameter of driving pulley;
$N_1$ = number of revolutions of driving pulley;
$F_1$ = diameter of driven pulley;
$n_1$ = number of revolutions of driven pulley.

$$\frac{N_1}{n_1} = \frac{F_1}{D_1}. \qquad \textbf{(136.)} \text{ Art. } \textbf{1477.}$$

$$D_1 N_1 = F_1 n_1.$$

### HORSEPOWER OF BELTS.

Let $H$ = horsepower to be transmitted;
$W$ = width of belt in inches;
$S$ = belt speed in feet per minute.

FOR SINGLE BELTS.

$$H = \frac{WS}{900}. \qquad \textbf{(138.)} \text{ Art. } \textbf{1488.}$$

$$W = \frac{900\,H}{S}. \qquad \textbf{(139.)} \text{ Art. } \textbf{1488.}$$

$$S = \frac{900\,H}{W}. \qquad \textbf{(140.)} \text{ Art. } \textbf{1488.}$$

FOR DOUBLE BELTS.

$$H = \frac{WS}{630}. \qquad \textbf{(141.)} \text{ Art. } \textbf{1489.}$$

$$W = \frac{630\,H}{S}. \qquad \textbf{(142.)} \text{ Art. } \textbf{1489.}$$

$$S = \frac{630\,H}{W}. \qquad \textbf{(143.)} \text{ Art. } \textbf{1489.}$$

### TEETH OF GEAR-WHEELS.

Let $P$ = diametral pitch;
$D$ = diameter of pitch circle of large gear;
$d$ = diameter of pitch circle of small gear;
$O\,D$ = outside diameter;

$C$ = circular pitch;
$N$ = number of teeth;
$A$ = distance between centers of wheels;
$V$ = velocity; i. e., revolutions per minute of large gear.
$v$ = velocity; i. e., revolutions per minute of small gear.

$$P = \frac{3.1416}{C}, \text{ and} \qquad \textbf{(149.)}$$

$$C = \frac{3.1416}{P}. \qquad \textbf{(150.)} \text{ Art. } \textbf{1556.}$$

$$N = DP. \qquad \textbf{(151.)} \text{ Art. } \textbf{1557.}$$

$$OD = \frac{N}{P} + 2 \times \frac{1}{P} = \frac{N+2}{P}. \qquad \textbf{(152.)} \text{ Art. } \textbf{1557.}$$

$$D = \frac{C \times N}{3.1416}. \qquad \textbf{(153.)} \text{ Art. } \textbf{1557.}$$

Given the distance between the centers of two gears and their velocities, the formulas for their diameters are

$$d = \frac{2AV}{V+v}; \qquad \textbf{(154.)}$$

$$\text{and} \quad D = \frac{2Av}{v+V}. \qquad \textbf{(155.)} \text{ Art. } \textbf{1557.}$$

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### THE PRONY BRAKE.

Let $H.\ P.$ = number of horsepower absorbed;
$R$ = length of lever arm in feet;
$W$ = weight in scale pan;
$N$ = number of revolutions per minute;
$r$ = length of lever arm in inches.

$$H.\ P. = \frac{2 \times 3.1416 \times R \times W \times N}{33{,}000}, \text{ or}$$

$$H.\ P. = .0001904\ R\ W N. \qquad \textbf{(156.)} \text{ Art. } \textbf{1593.}$$

$$H.\ P. = .00001586\ r\ W N. \qquad \textbf{(157.)} \text{ Art. } \textbf{1595.}$$

## FORMULAS USED IN STEAM BOILERS.

### STRENGTH OF BOILER SHELLS AND TUBES.

Let $p$ = the pressure of steam in pounds per square inch;
$t$ = thickness of plate in shell or tube;
$d$ = diameter of shell or tube;
$S_1$ = ultimate tensile strength of material;
$f$ = factor of safety;
$y$ = efficiency of joint;
$l$ = length of a tube subjected to external pressure.

For tubes without riveted joints,

$$t = \frac{f p d}{2 S_1}. \qquad \textbf{(164.)} \quad \text{Art. } \textbf{1730.}$$

$$p = \frac{2 t S_1}{f d}. \qquad \textbf{(166.)} \quad \text{Art. } \textbf{1731.}$$

For tubes or shells with riveted joints,

$$t = \frac{f p d}{2 S_1 y}, \qquad \textbf{(165.)}$$

$$p = \frac{2 t S_1 y}{f d}. \qquad \textbf{(167.)} \quad \text{Art. } \textbf{1731.}$$

For tubes subjected to external pressure,

$$p = 1{,}600{,}000 \frac{t^2}{l d} \qquad \textbf{(168.)} \quad \text{Art. } \textbf{1732.}$$

### RIVETED JOINTS.

Let $d$ = diameter of rivet hole in inches;
$h$ = pitch of rivets in inches;
$t$ = thickness of plate in inches.

$$h = \left(1 + \frac{7 d}{8 t}\right) d. \qquad \textbf{(169.)} \quad \text{Art. } \textbf{1742.}$$

For double-riveted lap joints or single butt joints, formula **169** becomes

$$h = \left(1 + \frac{7 d}{4 t}\right) d. \qquad \textbf{(170.)} \quad \text{Art. } \textbf{1742.}$$

For double-riveted double butt joints, formula **170** becomes

$$h = \left(1 + \frac{7d}{2t}\right)d. \qquad \textbf{(171.)} \text{ Art. } \textbf{1742.}$$

The $d$ in the above formulas refers to the diameter of the rivet hole, or of the rivet after being headed.

The diameter of the cold rivet is $\frac{1}{16}''$ less.

For single and double-riveted lap joints and butt joints, with one cover plate, the diameter of the rivet is

$$d = t + \tfrac{3}{8}'' \qquad \textbf{(172.)} \text{ Art. } \textbf{1742.}$$

for values of $t$ between $\frac{1}{4}''$ and $\frac{3}{4}''$. For butt joints with double cover plates, the diameter of rivet may be taken about $1\frac{1}{4}$ times the thickness of the plate.

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### FLAT SURFACES.

The strength of a circular plate supported at the edges, as, for example, the head of a boiler shell, is given by the following formula:

$$S = \frac{2r^2p}{3t^2}, \qquad \textbf{(174.)} \text{ Art. } \textbf{1751.}$$

$$t = r\sqrt{\frac{2p}{3S}}, \qquad \textbf{(175.)} \text{ Art. } \textbf{1751.}$$

where $S$ represents the safe tensile strength of the material, $r$ the radius of the plate in inches, $t$ the thickness of the plate in inches, and $p$ the pressure in lb. per sq. in.

The following formula gives the strength of a square unstayed flat plate fixed along the edge (the length of side is $a$):

$$\left.\begin{aligned} S &= \frac{a^2p}{4t^2}, \\ \text{or } t &= \frac{a}{2}\sqrt{\frac{p}{S}}. \end{aligned}\right\} \qquad \textbf{(176.)} \text{ Art. } \textbf{1752.}$$

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### BOILER STAYS.

Let $A$ = area in sq. in. of plate supported by one stay;
$d$ = smallest diameter of stay in inches;
$p$ = pressure of steam in pounds per sq. in.;

$T$ = safe stress per sq. in. allowed on stay;
$a$ = pitch for stays arranged at equal distances apart, both horizontally and vertically.

$$\left.\begin{aligned} \tfrac{1}{4}\pi d^2 T &= A p, \\ \text{or } d &= 1.13\sqrt{\frac{A p}{T}}. \end{aligned}\right\} \qquad \textbf{(177.)} \text{ Art. } \textbf{1756.}$$

$$d = 1.13\, a\sqrt{\frac{p}{T}}, \qquad \textbf{(178.)} \text{ Art. } \textbf{1756.}$$

$$\text{and } a = .885\, d\sqrt{\frac{T}{p}}. \qquad \textbf{(179.)} \text{ Art. } \textbf{1756.}$$

The values of $T$ used in formulas **177, 178,** and **179** may be taken as follows:

For copper screw staybolts..... $T = 4{,}000$

**Iron Stays.**—For screw stays, and for other stays not exceeding $1\frac{1}{4}$ inches in diameter, and for all stays which are welded..... $T = 6{,}000$

For unwelded stays above $1\frac{1}{2}$ inches effective diameter..... $T = 7{,}500$

**Steel Stays.**—For screw stays, and for other stays not exceeding $1\frac{1}{2}$ inches effective diameter..... $T = 8{,}000$

For stays above $1\frac{1}{2}$ inches effective diameter..... $T = 9{,}000$

No steel stays are to be welded.

The size of a diagonal stay may be calculated from formula **178** by substituting $\frac{p}{\cos B}$ for $p$, $B$ being the angle between the stay and the shell. Formula **178** thus becomes

$$d = 1.13\sqrt{\frac{A p}{T \cos B}}. \qquad \textbf{(180.)} \text{ Art. } \textbf{1758.}$$

For the strength of a girder stay:

Let $l$ = length of girder in inches;
$h$ = distance between adjacent girders in inches;
$p$ = steam pressure in lb. per sq. in.;
$b$ = breadth of girder in inches = $\frac{1}{4}\, d$;
$d$ = depth of girder in inches.

$$d = \sqrt[3]{\frac{p\,h\,l^2}{6{,}000}}. \qquad \textbf{(181.)} \quad \text{Art. } \textbf{1761.}$$

$$p = \frac{6{,}000\,d^3}{h\,l^2}. \qquad \textbf{(182.)} \quad \text{Art. } \textbf{1761.}$$

For the safe pressure allowable on a flat surface, strengthened by screw staybolts:

Let $p$ = pressure in lb. per sq. in.;
$h$ = pitch of staybolts;
$t$ = thickness of plate;
$k$ = a constant.

$$\text{Then, } p = k\frac{t^2}{h^2}, \qquad \textbf{(183.)}$$

$$\text{and } t = h\sqrt{\frac{p}{k}}. \qquad \textbf{(184.)} \quad \text{Art. } \textbf{1763.}$$

The constant $k$ has the following values:

For iron plates and iron bolts ..... $k = 24{,}000$
For low steel plates and iron bolts ..... $k = 25{,}000$
For low steel plates and low steel bolts ..... $k = 28{,}000$
For iron plates and iron bolts with nuts ..... $k = 40{,}000$
For copper plates and iron bolts ..... $k = 14{,}500$

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### SAFETY VALVES.

For a dead-weight safety valve:

Let $A$ = area of opening in valve seat in sq. in.;
$p$ = pressure at which the valve is to blow off (in lb. per sq. in.);
$W$ = dead weight in pounds (including weight of valve).

$$W = A\,p. \qquad \text{Art. } \textbf{1774.}$$

For a weighted-lever safety valve:

Let $d$ = $FB$ = distance from fulcrum to weight in inches;
$c$ = $FG$ = distance from fulcrum to center of gravity of lever in inches;

$a$ = $FV$ = distance from fulcrum to center of valve in inches;
$A$ = area of orifice beneath bottom of valve in inches;
$W$ = weight of weight $P$ in pounds;
$W_1$ = weight of valve and stem in pounds;
$W_2$ = weight of lever in pounds;
$P$ = blow-off pressure in pounds per sq. in.;
$W_3 = W_1 + W_2$ = combined weight of valve and lever;
$b$ = distance from fulcrum of center of gravity of $W_3$.

$$W = \frac{a(pA - W_1) - W_3 c}{d}, \qquad \textbf{(185.)} \text{ Art. } \textbf{1776.}$$

$$\text{and } d = \frac{a(pA - W_1) - W_3 c}{W}. \qquad \textbf{(186.)} \text{ Art. } \textbf{1776.}$$

$$\text{Also } d = \frac{pAa - W_3 b}{W}. \qquad \textbf{(187.)} \text{ Art. } \textbf{1778.}$$

To find the area of a safety valve:

Let $a$ = area of the valve opening in square inches;
$w$ = maximum weight of steam generated in pounds per hour;
$p$ = gauge pressure in pounds per square inch.

$$a = \frac{.5\,w}{p + 10}. \qquad \textbf{(188.)} \text{ Art. } \textbf{1781.}$$

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**DIMENSIONS OF CHIMNEYS.**

Let $H$ = height of chimney in feet;
$H.P.$ = horsepower of boiler or boilers;
$A$ = actual area of chimney in square feet;
$E$ = effective area of chimney in square feet;
$S$ = side of square chimney in inches;
$d$ = diameter of round chimney in inches;
$p$ = pressure of draft in inches of water;
$T_a$ = absolute temperature of outside air;
$T_c$ = absolute temperature of gas in chimney.

$$p = H\left(\frac{7.6}{T_a} - \frac{7.9}{T_c}\right). \qquad \textbf{(192.)} \text{ Art. } \textbf{1825.}$$

$$H = \frac{p}{\left(\frac{7.6}{T_a} - \frac{7.9}{T_c}\right)}. \qquad \textbf{(193.)} \text{ Art. } \textbf{1826.}$$

$$E = \frac{.3\,H.\,P.}{\sqrt{H}} = A - .6\sqrt{A}. \qquad \textbf{(194.)} \text{ Art. } \textbf{1827.}$$

$$H.\,P. = 3.33\,E\sqrt{H}. \qquad \textbf{(195.)} \text{ Art. } \textbf{1827.}$$

$$S = 12\sqrt{E} + 4. \qquad \textbf{(196.)} \text{ Art. } \textbf{1827.}$$

$$d = 13.54\sqrt{E} + 4. \qquad \textbf{(197.)} \text{ Art. } \textbf{1827.}$$

The *maximum* rates of combustion attainable under natural draft are given by the following formulas:

Let $F$ = weight in pounds of coal per hour per square foot of grate area;
$H$ = height in feet of chimney or stack.

Then, for anthracite coal burned under the most favorable conditions,

$$F = 2\sqrt{H} - 1, \qquad \textbf{(198.)} \text{ Art. } \textbf{1829.}$$

and under ordinary conditions,

$$F = 1.5\sqrt{H} - 1. \qquad \textbf{(199.)} \text{ Art. } \textbf{1829.}$$

For best semianthracite and bituminous coals,

$$F = 2.25\sqrt{H}, \qquad \textbf{(200.)} \text{ Art. } \textbf{1829.}$$

and for less valuable soft coals,

$$F = 3\sqrt{H}. \qquad \textbf{(201.)} \text{ Art. } \textbf{1829.}$$

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### GRATE AREA.

Let $G$ = area of grate in sq. ft.;
$F$ = rate of combustion in lb. per sq. ft. of grate surface per hour;
$W$ = weight of steam generated per hour by boiler or boilers;
$e$ = evaporation in pounds of water per pound of coal per hour.

Then, $$G = \frac{W}{Fe}. \qquad \textbf{(202.)} \text{ Art. } \textbf{1830.}$$

In using this formula care must be taken that $W$ and $e$ are taken at the same pressure and temperature.

**TO REDUCE THE ACTUAL EVAPORATION TO AN EQUIVALENT EVAPORATION.**

Let $W$ = the actual evaporation;
$H$ = total heat of steam above 32° at pressure of actual evaporation;
$t$ = observed temperature of feed-water;
$W'$ = equivalent evaporation from and at 212°.

Then, $W(H - t + 32) = 966.1\ W'$,

$$\text{or } W' = \frac{W(H - t + 32)}{966.1}. \qquad \textbf{(203.)} \text{ Art. } \textbf{1838.}$$

The quantity $\left(\frac{H - t + 32}{966.1}\right)$ which changes actual evaporation to equivalent evaporation from and at 212° is called the **factor of evaporation.**

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**TO FIND THE QUALITY OF STEAM BY MEANS OF THE BARREL CALORIMETER.**

Let $W$ = original weight of water in barrel;
$w$ = weight of steam and water condensed in the cold water;
$l$ = latent heat of steam at observed pressure;
$t$ = temperature of steam at observed pressure;
$t_1$ = initial temperature of water;
$t_2$ = final temperature of water;
$x$ = the portion of $w$ which is dry steam;
$Q$ = quality of steam; that is, the percentage of the mixture evaporated, which is pure dry steam.

$$Q = \frac{x}{w} = \frac{1}{l}\left[\frac{W}{w}(t_2 - t_1) - (t - t_2)\right]. \qquad \textbf{(204.)} \text{ Art. } \textbf{1853.}$$

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**TO FIND THE QUALITY OF STEAM BY MEANS OF THE SEPARATOR CALORIMETER.**

Let $W$ = weight of dry steam discharged from the instrument;
$w$ = weight of water drawn from separator;
$R$ = water condensed by radiation:
$Q$ = quality of steam.

$$Q = \frac{W + R}{W + R + w}. \qquad \textbf{(205.)} \text{ Art. } \textbf{1855.}$$

## FORMULAS USED IN MACHINE DESIGN.

### PROPORTIONS OF BOLT HEADS, NUTS, AND WASHERS.

$d =$ diameter of bolt.

Diameter of nut or head across flats:

$$\left.\begin{array}{l} D = 1\tfrac{1}{2}\,d + \tfrac{1}{8}'' \text{ for rough work.} \\ D = 1\tfrac{1}{2}\,d + \tfrac{1}{16}'' \text{ for finished work.} \end{array}\right\} \quad \textbf{(220.)} \text{ Art. } \textbf{1937.}$$

Height of nut:

$$\left.\begin{array}{l} h = d \text{ for rough work.} \\ h = d - \tfrac{1}{16}'' \text{ for finished work.} \end{array}\right\} \quad \textbf{(221.)} \text{ Art. } \textbf{1937.}$$

Thickness of washer, $t = .15\,d$. **(222.)** Art. **1937.**

Diameter of washer, $D_2 = 1\tfrac{1}{8}\,D_1$. **(223.)** Art. **1937.**

The above proportions for diameters $D$ hold for both hexagonal and square nuts. The diameter across corners $D_1$ is as follows:

For hexagonal nuts:

$$D_1 = \left\{\begin{array}{l} 1.73\,d + .14'' \text{ for rough nuts.} \\ 1.73\,d + .07'' \text{ for finished nuts.} \end{array}\right. \quad \textbf{(224.)} \text{ Art. } \textbf{1937.}$$

For square nuts:

$$D_1 = \left\{\begin{array}{l} 2.12\,d + .18'' \text{ for rough nuts.} \\ 2.12\,d + .09'' \text{ for finished nuts.} \end{array}\right. \quad \textbf{(225.)} \text{ Art. } \textbf{1937.}$$

Height of head:

$$\left.\begin{array}{l} h' = \tfrac{3}{4}\,d + \tfrac{1}{16}'' \text{ for rough bolts.} \\ h' = \quad d - \tfrac{1}{16}'' \text{ for finished bolts.} \end{array}\right\} \quad \textbf{(226.)} \text{ Art. } \textbf{1937.}$$

### PROPORTIONS OF KEYS.

Let $b$ = width of key in inches;
$t$ = thickness of key in inches;
$l$ = length of key in inches;
$N$ = number of revolutions per minute;
$H$ = horsepower transmitted by a pulley.

$$\left.\begin{array}{l} b = \dfrac{d}{7} + \dfrac{1}{4}''. \\ t = \dfrac{d}{12} + \dfrac{3}{16}''. \end{array}\right\} \text{ For driven pulleys.} \quad \textbf{(234.)} \text{ Art. } \textbf{1965.}$$

$$\left.\begin{array}{l} b = .2\,d + .16''. \\ t = .1\,d + .16''. \end{array}\right\} \text{For driving pulleys.} \qquad \textbf{(235.)} \text{ Art. } \textbf{1965.}$$

$$\text{When } d \text{ is less than } 1\tfrac{3}{16} \text{ in.,} \quad \left.\begin{array}{l} b = \dfrac{d}{3}. \\ t = \dfrac{d}{5}. \end{array}\right\} \qquad \textbf{(236.)} \text{ Art. } \textbf{1965.}$$

When the pulley transmits but a small part of the power of a shaft, use the formula $d = 5\sqrt[3]{\frac{H}{N}}$ from which to obtain the value of $d$ to use in formula **236.**

For sliding feather keys,

$$\left.\begin{array}{l} b = \dfrac{d}{8} + \dfrac{1}{16}'. \\ t = \dfrac{3\,d}{16} + \dfrac{1}{16}'. \end{array}\right\} \qquad \textbf{(237.)} \text{ Art. } \textbf{1965.}$$

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**PROPORTIONS AND STRENGTH OF GEAR-WHEELS.**

Let $p$ = pressure acting at pitch line;
$b$ = breadth of tooth;
$n$ = number of revolutions per minute;
$H$ = horsepower transmitted;
$D$ = diameter of gear in inches;
$C$ = the circular pitch;
$P$ = diametral pitch;
$S$ = allowable working stress in tooth;
$v$ = velocity of a point in the pitch circle in feet per minute;
$c$ = thickness of rim.

$$b\,C = 16.8\frac{p}{S}. \qquad \textbf{(266.)} \text{ Art. } \textbf{2024.}$$

If $v$ is greater than 100 feet per minute make

$$S = \frac{9{,}600{,}000}{v + 2{,}160}. \qquad \textbf{(267.)} \text{ Art. } \textbf{2024.}$$

To insure durability make

$$\frac{p\,n}{b} = 28{,}000, \text{ or } b = 4\tfrac{1}{2}\frac{H}{D}. \qquad \textbf{(268.)} \text{ Art. } \textbf{2025.}$$

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To calculate the dimensions of the arms·

Let $z$ = number of arms in wheel;
$a$ = width of arm, measured at center of wheel;
$x$ = thickness of arm;
$S_1$ = allowable safe stress in arm;
$R$ = radius of wheel in inches;
$p$ = pressure between gears at pitch line.

For cross-shaped, **T**, or **I** sections:

$$\left.\begin{aligned} a &= \sqrt{\frac{Rb}{z}}. \\ x &= \tfrac{1}{2}C. \end{aligned}\right\} \quad \textbf{(270.)} \text{ Art. } \textbf{2030.}$$

For oval or elliptical sections:

$$\left.\begin{aligned} a &= 1.2\sqrt[3]{\frac{bCR}{z}}. \\ a &= 1.75\sqrt[3]{\frac{bR}{Pz}}. \end{aligned}\right\} \quad \textbf{(271.)} \text{ Art. } \textbf{2030.}$$

$$x = \frac{a}{2}.$$

For thickness of rim:

$c = \frac{1}{2}\,C$ for large gears and coarse pitch.
$c = .4\,C \times \frac{1}{8}''$ for gears with small pitch.

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**PROPORTIONS OF BEVEL GEARS.**

Denote the mean circular pitch by $C_m$.

Then, $$b\,C_m = 16.8\frac{p}{S}. \quad \textbf{(266}a.\textbf{)} \text{ Art. } \textbf{2033.}$$

$$c = .4\,C_m + \tfrac{1}{8}'' = \frac{5}{4P} + \tfrac{1}{8}''. \quad \textbf{(269}a.\textbf{)} \text{ Art. } \textbf{2033.}$$

$$\left.\begin{aligned} a &= \sqrt{\frac{Rb}{z}}. \\ x &= \tfrac{1}{2}C_m. \end{aligned}\right\} \quad \textbf{(270}a.\textbf{)} \text{ Art. } \textbf{2033.}$$

$$\left.\begin{aligned} a &= 1.2\sqrt[3]{\frac{bC_mR}{z}}. \\ a &= 1.75\sqrt[3]{\frac{bR}{P_mz}}. \end{aligned}\right\} \quad \textbf{(271}a.\textbf{)} \text{ Art. } \textbf{2033.}$$

## RULES AND FORMULAS USED IN DYNAMOS AND MOTORS.

### DIRECTION OF LINES OF FORCE AROUND A CONDUCTOR.

**Rule.**—*If the current is flowing in the conductor away from the observer, then the direction of the lines of force will be around the conductor in the direction of the hands of a watch.* *Art.* **2157.**

### TO DETERMINE THE POLARITY OF A SOLENOID.

**Rule.**—*In looking at the end of the helix, if it is so wound that the current circulates around the helix in the direction of the hands of a watch, that end will be a south pole; if in the other direction it will be a north pole.* *Art.* **2160.**

### RESISTANCE OF CONDUCTORS.

Let $r_1$ = the original resistance of a conductor;
$r_2$ = the changed resistance:
$l_1$ = the original length;
$l_2$ = the changed length;
$a_1$ = the original sectional area;
$a_2$ = the changed sectional area;
$D$ = the original diameter;
$d$ = the changed diameter;
$k$ = temperature coefficient;
$t$ = rise or fall in temperature, degrees Fahrenheit.

For a change in the length of a conductor:

$$r_2 = \frac{r_1 l_2}{l_1}. \qquad \textbf{(306.)} \quad \text{Art. } \textbf{2171.}$$

For a change in the sectional area of a conductor:

$$r_2 = \frac{r_1 a_1}{a_2}. \qquad \textbf{(307.)} \quad \text{Art. } \textbf{2172.}$$

For a change in the diameter of a conductor:

$$r_2 = \frac{r_1 D^2}{d^2}. \qquad \textbf{(308.)} \quad \text{Art. } \textbf{2173.}$$

For a rise in the temperature of a conductor:

$$r_2 = r_1 (1 + t k). \qquad \textbf{(309.)} \quad \text{Art. } \textbf{2177.}$$

For a fall in the temperature of a conductor:

$$r_2 = \frac{r_1}{1 + t k}. \qquad \textbf{(310.)} \quad \text{Art. } \textbf{2178.}$$

**RESISTANCES AND TEMPERATURE COEFFICIENTS OF DIFFERENT METALS.**

| Name of Metal. | Resistance, Microhms per Cu. In. | Relative Resistance. | Temperature Coefficient. |
|---|---|---|---|
| Silver, annealed..... | .5921 | 1. | .002094 |
| Copper, annealed.... | .6292 | 1.063 | .002155 |
| Silver, hard-drawn... | .6433 | 1.086 | .002094 |
| Copper, hard-drawn.. | .6433 | 1.086 | .002155 |
| Gold, annealed..... | .8102 | 1.369 | .002028 |
| Gold, hard-drawn.... | .8247 | 1.393 | .002028 |
| Aluminum, annealed | 1.1470 | 1.935 | ..... |
| Zinc, pressed..... | 2.215 | 3.741 | .002028 |
| Platinum, annealed. | 3.565 | 6.022 | ..... |
| Iron, annealed..... | 3.825 | 6.460 | ..... |
| Nickel, annealed .... | 4.907 | 8.285 | ..... |
| Tin, pressed..... | 5.202 | 8.784 | .002028 |
| Lead, pressed..... | 7.728 | 13.05 | .002150 |
| German silver..... | 8.240 | 13.92 | .000244 |
| Antimony, pressed... | 13.98 | 23.60 | .002161 |
| Mercury ..... | 37.15 | 62.73 | .000400 |
| Bismuth, pressed.... | 51.65 | 87.23 | .001967 |

**CURRENT STRENGTH, ELECTROMOTIVE FORCE, AND RESISTANCE.**

Let $C$ = strength of current flowing in a closed circuit;
$E$ = electromotive force;
$R$ = resistance.

$$C = \frac{E}{R}. \qquad \textbf{(311.)} \quad \text{Art. } \textbf{2192.}$$

$$R = \frac{E}{C}. \qquad \textbf{(312.)} \quad \text{Art. } \textbf{2193.}$$

$$E = C\,R. \qquad \textbf{(313.)} \quad \text{Art. } \textbf{2194.}$$

---

**TO FIND THE AVAILABLE ELECTROMOTIVE FORCE IN A CELL.**

Let $E$ = the total generated E. M. F.;
$E'$ = *available* E. M. F. when the circuit is closed;
$C$ = the current flowing when the circuit is closed;
$r_i$ = the internal resistance of the cell.

$$E' = E - Cr_i. \qquad \textbf{(314.)} \quad \text{Art. } \textbf{2198.}$$

---

**THE CURRENT AND RESISTANCE IN BRANCHES OF DIVIDED CONDUCTORS.**

Let $r_1$ = resistance of first branch;
$r_2$ = resistance of second branch;
$r_3$ = resistance of third branch;
$c_1$ = current in first branch;
$c_2$ = current in second branch;
$C$ = sum of the currents in the two branches;
$R''$ = joint resistance of two branches in parallel;
$R'''$ = joint resistance of three branches in parallel.

$$c_1 = \frac{C r_2}{r_1 + r_2}. \qquad \textbf{(315.)} \quad \text{Art. } \textbf{2200.}$$

$$c_2 = \frac{C r_1}{r_1 + r_2}. \qquad \textbf{(316.)} \quad \text{Art. } \textbf{2200.}$$

$$R'' = \frac{r_1 r_2}{r_1 + r_2}. \qquad \textbf{(317.)} \quad \text{Art. } \textbf{2202.}$$

$$R''' = \frac{r_1 r_2 r_3}{r_2 r_3 + r_1 r_3 + r_1 r_2}. \qquad \textbf{(318.)} \quad \text{Art. } \textbf{2203.}$$

---

**ELECTRICAL QUANTITY.**

Let $Q$ = quantity of electricity in coulombs;
$C$ = current strength in amperes;
$t$ = time in seconds;

$$Q = C\,t. \qquad \textbf{(319.)} \quad \text{Art. } \textbf{2207.}$$

### ELECTRICAL WORK AND POWER.

$J$ = electrical work in joules;
$F\text{-}P$ = work in foot-pounds;
$Q$ = quantity of electricity in coulombs;
$C$ = current in amperes;
$t$ = time in seconds during which the current flows;
$E$ = potential, or E. M. F., of circuit;
$R$ = resistance of circuit;
$W$ = power in watts;
$H.\ P.$ = horsepower.

$$J = CEt. \qquad (320.)$$ Art. **2209.**

$$J = C^2Rt. \qquad (321.)$$ Art. **2209.**

$$J = \frac{E^2t}{R}. \qquad (322.)$$ Art. **2209.**

$$F\text{-}P = .7373J. \qquad (323.)$$ Art. **2210.**

$$W = CE. \qquad (324.)$$ Art. **2211.**

$$W = C^2R. \qquad (325.)$$ Art. **2211.**

$$W = \frac{E^2}{R}. \qquad (326.)$$ Art. **2211.**

$$H.\ P. = \frac{W}{746}. \qquad (327.)$$ Art. **2212.**

$$W = H.\ P. \times 746. \qquad (328.)$$ Art. **2213.**

---

### TO DETERMINE THE DIRECTION OF THE CURRENT GENERATED IN A CONDUCTOR.

**Rule.**—*Place thumb, forefinger, and middle finger of the right hand so that each will be perpendicular to the other two; if the forefinger points in the direction of the lines of force, and the thumb points in the direction towards which the conductor is moving, then the middle finger will point in the direction towards which the current generated in the conductor tends to flow.* Art. **2221.**

### DETERMINATION OF ELECTROMOTIVE FORCE.

Let $E$ = maximum electromotive force obtained at the brushes;

$N$ = total number of lines of force passing from north pole through the core to the south pole;

$S$ = number of outside wires on the periphery through which the current flows *in series;*

$n$ = number of complete revolutions per second of core.

$$E = \frac{2NSn}{10^8}. \qquad \textbf{(329.)} \quad \text{Art. } \textbf{2236.}$$

---

### TO DETERMINE THE DIRECTION OF MOTION IMPARTED TO A CONDUCTOR.

**Rule.**—*Place thumb, forefinger, and middle finger of the left hand each at right angles to the other two; if the forefinger points in the direction of the lines of force, and the middle finger points in the direction towards which the current flows, then the thumb will point in the direction of movement imparted to the conductor.* Art. **2239.**

---

### EFFICIENCY OF A DYNAMO.

Let $I$ = input of a dynamo;

$O$ = output;

$\mathsf{E}$ = efficiency, per cent.

$$\mathsf{E} = \frac{100 \times O}{I}. \qquad \textbf{(330.)} \quad \text{Art. } \textbf{2273.}$$

---

### PER CENT. LOSS IN A DYNAMO.

Let $L$ = per cent. loss;

$I$ = input;

$O$ = output.

$$L = \frac{100\,(I - O)}{I}. \qquad \textbf{(331.)} \quad \text{Art. } \textbf{2274.}$$

When the output and efficiency are given:

$$I = \frac{100 \times O}{\mathsf{E}}. \qquad \textbf{(332.)} \quad \text{Art. } \textbf{2275.}$$

When the input and efficiency are given:

$$O = \frac{I\,E}{100}. \qquad \textbf{(333.)} \quad \text{Art. } \textbf{2276.}$$

---

**HORSEPOWER, TORQUE, AND NUMBER OF REVOLUTIONS OF MOTORS.**

Let $H.\ P.$ = horsepower.
$T$ = torque;
$S$ = number of revolutions per minute.

$$H.\ P. = .0001904\ T\,S. \qquad \textbf{(334.)} \quad \text{Art. } \textbf{2346.}$$

$$S = \frac{H.\ P.}{.0001904\ T}. \qquad \textbf{(335.)} \quad \text{Art. } \textbf{2346.}$$

$$T = \frac{H.\ P.}{.0001904\ S}. \qquad \textbf{(336.)} \quad \text{Art. } \textbf{2346.}$$

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